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JOHN F. DASHIELL, *Editor*

An Analysis of Certain Psychological Tests Used for the Evaluation of Brain Injury

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TABLE OF CONTENTS

I. INTRODUCTION	1
II. WHAT IS THE BRAIN INJURED PATIENT LIKE?	4
A. Intellect	5
B. Affect	7
III. CRITIQUE OF TESTS PREVIOUSLY USED	9
A. The Wechsler Mental Ability Scale	9
B. The Shipley-Hartford Retreat Scale for Intellectual Impairment	14
C. The Hunt-Minnesota Test for Organic Brain Damage	16
D. The Rorschach Test	16
IV. REQUIREMENTS FOR A SCREENING TEST	22
V. PROPOSED SCREENING TEST	24
A. Methods and Procedure	24
B. Case Material	24
C. Results	26
I. Memory Tests	26
II. Trail Making Test	30
III. Patch Test	34
IV. The Goldstein-Scheerer Cube Test	38
V. The Stanford-Binet Vocabulary Test	41
VI. Sub-Test Interrelationship	42
D. Critique of the Screening Test	44
VI. SUMMARY AND CONCLUSIONS	47
BIBLIOGRAPHY	48

AN ANALYSIS OF CERTAIN PSYCHOLOGICAL TESTS USED FOR THE EVALUATION OF BRAIN INJURY*

I. INTRODUCTION

ONE TYPE of battle casualty which has had increasing attention in both medicine and psychology is brain injury. The problems of diagnosis, symptomatology (mental and physical), re-education, and rehabilitation are of the utmost importance. Each of these problems, to some extent, falls into the field of clinical psychology. Through the proper use of existing measures the clinical psychologist can aid in: (1) Differential diagnoses; (2) The estimation of previous and present levels of capability; (3) The determination of personality dysfunction; (4) The detection of specific losses in mental efficiency; and (5) The development of a program for re-education and rehabilitation. This does not mean that all of the psychological questions regarding brain injury have been answered. Research is particularly needed in explaining the biological-psychological relationships of behavior manifested by brain injured persons.

The collation of data obtained through the analysis of different psychological measures administered to various types of mental entities furthers test development. The new approaches thus provided make it possible to assemble a more complete and accurate clinical picture. It is only through the constant application of the experimental technique that clinical psychology can keep abreast of its rapidly expanding scope.

Clinical psychology has advanced beyond the state of mere quantitative

measurement of specifically defined traits and abilities. The considerations necessary in the field are rapidly approaching the goal of understanding the interrelationships of human characteristics. Recent studies by Rapaport (23) indicate that the trend in psychological investigation is toward the evaluation of individual test results as a part of a behavioral picture. For example, the data obtained from the Wechsler-Bellevue (32) is no longer considered a mere indicator of intellectual level alone, but is also of assistance in the detection of specific personality maladjustments and the presence of possible organic cerebral alteration. The use of projective techniques such as the Rorschach (25) and the Thematic Apperception Test (21) are furthering the clinical psychologist's appreciation of the value in understanding the individual as an integrated whole. With this concept as a frame of reference, perhaps something can be gained by re-examining the previously mentioned uses of clinical psychology insofar as the brain injured individual is concerned.

The estimation of the level of capability and the determination of specific functional losses will be discussed together. As Goldstein has discussed in detail, the IQ is often misleading and is of limited value in cases of brain injury (8). A full scale score obtained from such measures as the Wechsler Mental Abilities Scale (Form B) (or MAS) (33) or the Wechsler-Bellevue (32), however, does provide a good estimation of an individual's position in relation to the general population. It serves as a base line against which impairment can be

* We are indebted to Captain J. A. Aita, M.C., AUS, for neurological evaluation of brain injured cases used in this paper, and to Mr. Ralph M. Reitan for contributing those sections of the paper dealing with the Rorschach findings.

measured, and also as a rough estimate in evaluating the brain injured patient's general capability for future job placement. However, the IQ has all of the disadvantages of any mean as it gives very little indication of the actual status of the components which make up the average. The assumption that all intellectual functions measured contribute equally to the total result is a hypothetical consideration. Actually, as every cli-

in isolation is only a single and often unreliable segment of the total behavioral pattern.

In the diagnosis of personality disorders certain clinical tests are extremely helpful. In many cases by the proper use of certain of them it is not only possible to label the disorder but, through such projective techniques as the Thematic Apperception Test (21), the cause may be indicated. However, in determining the presence of brain damage, it is extremely doubtful that any psychological measure will approach the validity of the pneumo-encephalogram, surgeon's reports, and neurological findings. The most important consideration of psychological testing is not to give a positive or negative statement as to the presence of cerebral alteration. The primary concern of the psychologist should be to discover personality or behavioral changes typical of brain injury and determine their influence upon future adjustments. Rather than to attempt a diagnosis of the presence of brain injury, psychological tests should attempt to answer questions such as: (1) Has the injury created a definite loss in intellectual functioning? (2) What specific abilities have been retarded? (3) Has the personality structure undergone changes, either of a temporary or a permanent nature? (4) To what extent are education and rehabilitation possible? (5) Where will the patient fit into the social structure in the future? It is the opinion of the writer that too much emphasis in clinical psychology has been placed on the diagnostic aspect and too little on the points enumerated above. This possibly has been a consequence of a different scale of values which had to be adopted during the war period. The press of psychological casualties of all

TABLE 1
A partial Wechsler-Bellevue record of a severely brain damaged patient

Tests	Weighted Score
Information	8
Comprehension	9
Arithmetic	1
Digit Span	9
Similarities	4
Verbal Score	31
Picture Completion	8
Picture Arrangement	3
Object Assembly	1
Block Design	1
Digit Symbol	2
Performance Score	15
Total Score	46
Verbal Score	31—IQ—83
Performance Score	15—IQ—66
Full Scale Score	46—IQ—73

nician knows, there is nearly always a degree of sub-test scatter. Thus it becomes necessary to evaluate the IQ in terms of the sub-test, especially when dealing with brain damaged patients. A partial Wechsler-Bellevue (32) record of a brain injured patient is given in Table 1. On the basis of the total score the assumption may be made that the patient was operating on a border-line defective level. Omitting those scores that have been found to be relatively unaffected by post-traumatic brain injury (1), it is apparent that the obtained IQ is not adequate evaluation of the patient's intelligence. The IQ considered

types increased the importance of correct classification. This is a trend away from the concept of total behavior, and a readjustment of attitude and thinking should occur to insure the continued advance of clinical psychology.

Although re-education and rehabilitation are not topics to be discussed in this paper, they are of vital concern to the brain injured patient. He is faced with such problems as the ability to earn an adequate living wage and to otherwise make an adequate social adjustment. Consequently a great deal of worry and anxiety occurs which, if left unheeded, may develop into a definite neurosis. As

a preventative measure there has been instituted a program of occupational therapy in all military hospitals. Keeping the patient occupied is sound practice and has been exceptionally fruitful. In conjunction with occupational therapy, educational reconditioning classes are conducted. They provide instruction in such trades as radio, mechanics, carpentry, etc. and use the facilities of the United States Armed Forces Institute. The extent to which these programs will succeed for the individual brain injured patient is determined to a large degree by the recommendations of the clinical psychologist.

II. WHAT IS THE BRAIN INJURED PATIENT LIKE?

IN AN excellent review of the literature, Klebanoff (17) has collated a vast amount of previously published data in an attempt to determine the psychological residuals of brain damage. In reading the article one is impressed with the fact that conclusions have been drawn from relatively limited samples and that questionable tests and testing techniques have been employed. These deficiencies are clearly indicated in his conclusions: "It is felt that experimental progress demands the satisfaction of two methodological considerations. First . . . must involve comparisons between . . . organic brain disorders and normal persons. Second . . . specialized test development should be directed toward the various spheres of possible psychological impairment". Certainly these aims are basic. However, there are other aspects that should not be overlooked. One of these is the source of the injury. The brain injured cases to be considered in this paper all suffered post-traumatic injuries. In a recent publication an exhaustive inquiry has been made into this type of injury. Two of the contributors, Gurdjian and Webster (10) present a study of a variety of experimentally produced head injuries. The means of creating the damage roughly corresponds to the source of most of the injuries received by the patients to be considered in this publication. In general their results point to the difficulty involved in determining whether an injury is of a focal or diffuse nature. Of the patients used in the present study who were known to have definite cerebral injury, only 12% were considered to be purely focal by the neurologist. The others were classed either as focal-diffuse or diffuse. Because of the nature of our case material we are not

in a position to attempt a correlation of behavioral changes with injury to a specific cortical area. It is our opinion that this can be attempted only when dealing with pure focal surgical lesions similar to those reported by Freeman and Watts (7).

Another consideration is the presence or suspected presence of personality alteration. If such changes have occurred, how do they affect the psychological test results? It is very likely that some of the indications given by the tests may be due to personality dysfunction precipitated by the injury and not to cerebral damage. Experimentally this distinction becomes important. Again it will not be possible to give any conclusive statements in this respect. All evidence will of necessity be indirect or comparative as our case records indicate little of the personality structure or adjustments of the individual patients before the injuries occurred. The study of Freeman and Watts (7) is one of the few that has been adequately controlled in this sense. In addition their cases are being followed up and from such procedure much valuable data should be obtained.

The final point is the necessity of comparing the test results of the brain injured patient with results from groups of patients representing all other types of mental disorders. It is of importance to ascertain whether the performance of a brain damaged patient is characteristic or similar to that obtained, for example, from a schizophrenic. Only by means of such a technique can the question of test validity be completely settled.

With all of these points as a background, it is our purpose to consider the post traumatic brain injured patient from the standpoint of intellect and affect.

A. INTELLECT

It is difficult to estimate pre-injury intellect but it has been noted that certain Wechsler-Bellevue and MAS items such as vocabulary and information appear to remain approximately at their previous level (1). Using these items as base lines and comparing the results of the remaining sub-tests to them it is

shown in Table 2. Slightly more than half of those patients who had suffered definite injury had an accompanying definite intellectual loss according to our measurements. Certainly the failure of 47% of the patients to show any retardation requires explanation. The following variables, any one of which might account for the above results, are presented

TABLE 2
Intellectual changes following post traumatic brain injury
as indicated by the MAS and Rorschach

Previous Level	N	Patients Maintaining Previous Level		Patients Below Previous Level	
		N	%	N	%
Above average	13	4	31	9	69
Average	37	20	54	17	46
Below Average	10	4	40	6	60
Total	60	28	47	32	53

possible to determine roughly the extent of intellectual loss. However, this technique is not completely valid. Hunt (15) lists a number of methodological criticisms and Babcock (5), who is largely responsible for this method, indicates that vocabulary suffers when the deterioration is severe. In order to obtain as accurate an estimate as possible, the findings from the MAS and the Rorschach were collated. This method curtailed the size of the sample but lent credence to the assumed pre-injury mental level. As an added check the prior AGCT [Army General Classification Test] scores were utilized and, although not intelligence measures, they were of value. The Rorschach data is of exceptional interest. When combined with the MAS results it is not only possible to get indications of pre-and post-injury ability, but further information is gained regarding the efficiency with which this ability is being utilized, the amount of drive, and the present affective picture. The results are

for consideration: (1) Injuries to certain cortical areas may not be followed by losses in mental ability; (2) The severity and/or type of trauma and the severity and/or type of consequent injury may have been responsible; (3) Previous intelligence level, degree of education or training, and cultural or occupational background may have masked actually existing changes; (4) Inaccuracies in estimating the previous intelligence level may have occurred; (5) The tests themselves may have been too restricted; that is, all functions and/or areas of possible impairment may not have been tapped; (6) Malingering, either on a conscious or unconscious level may have been a factor; (7) Closely allied to the above are the possible effects on the test results of affective dysfunction; and (8) Perhaps the effects of the injury were transitory and improvement before the patient was tested was sufficient to erase any previously existing losses.

As has already been indicated, the

case material studied was such that it was impossible to relate specific areas of injury to changes in intellect or affect. The sample was divided into the broad categories of mild, moderate, and severe injury. The results of this breakdown are shown in Table 3. The number of cases in the sub-groups are much too

indicated by the data. The technique is crude and only outstanding generalized retardation can be readily determined. Whether the tests used were adequate is a point that only further experimentation can definitely establish. Previous investigations have shown them to be of some value (1).

TABLE 3
The composition of the groups shown in Table 2 in respect to mild, moderate and severe brain injuries

Group	Number			Percent of Mild, Mod., Severe Below Previous Level			Percent of Mild, Mod., Severe Retain. Previous Level		
	Mild	Mod.	Severe	Mild	Mod.	Severe	Mild	Mod.	Severe
Above Average	7	6	0	71	67	0	29	33	0
Average	18	9	10	39	22	80	61	78	20
Below Average	3	6	1	67	67	0	33	33	100
Total	28	21	11	50	48	73	50	52	27

small to be of definite significance. Only in the total group with severe injuries did any relationship exist between the extent of injury and reduction in intellect. These results do not include consideration of the type (focal, focal-diffuse, diffuse) or area of the injury. The composition of the intelligence groupings shown in Table 2, in respect to type, were found to be virtually identical.

The training, educational, cultural, and occupational backgrounds, although not identical were not too dissimilar. However, all of these data were obtained directly from the patients with the existing possibility of inaccurate statements. No reason for falsification of this information by the subjects was apparent, however, and we believe that the data are fairly accurate.

The estimation of the previous intelligence level leaves much to be desired. The categories into which the patients were divided are too broad to allow the detection of limited changes. Therefore, changes may be present which are not

Malingering is difficult to prove. However, as all tests were given individually, it is our opinion that it did not occur on a conscious level. The possibility was present of unconscious evasion as a result of an affective maladjustment but if it was present the extent was impossible to determine.

A series of articles by Ruesch (26), Ruesch and Moore (27), and Moore and Ruesch (20) indicates that improvement in mental ability does occur after brain injury particularly during the first few weeks. Inasmuch as most of our tests were given six months after injury this may partially account for the high percentage of subjects whose post-injury test results classified them in the same intelligence range as their estimated pre-injury intelligence.

To summate, it is evident that there are too many indeterminate variables present to allow any conclusive statements as to the effects of brain injury on intelligence. All that can be concluded is that some of the patients did undergo

definite measurable mental alteration. The specific functions that appear to be most vulnerable have been considered in a previous study (1).

B. AFFECT

Affective disorders occurring after head injury have been noted and described by various writers. One of the earliest of these was Adolph Meyer, who in 1904 published an article (19) in which he described the sequelae as usually consisting of prolonged periods of confusion with hallucinatory episodes and subsequent recovery. He also noted that other disturbances were frequently present, such as impaired retentive memory, retardation in the flow of thought, extreme fatiguability, irritability, headaches, and intolerance to alcohol. Schilder published a significant paper in 1934 (28), in which he discussed disturbances ranging from temporary confusion following injury to a catatonic picture which was still present at a recheck after the patient had been discharged from the hospital.

The patients that we have studied were admitted to the hospital usually from three to six months following injury, and therefore we will not discuss the temporary confusion and disorientation immediately following recovery of consciousness. Rather, we will be concerned in this section with describing affective disorders which either develop after the injury or are semi-permanent in nature.

In another study (2), we have noted certain disturbances which are frequently present among persons who have suffered head injury. Rorschach's test indicated that anxiety, depressive tendencies and hypochondriasis were often present. Occasionally records gave indications which were markedly schizophrenic-like in nature. Emotional control was not significantly impaired, according to the Ror-

schach findings, except among patients with severe injuries.

Schilder has found substantially the same group of symptoms (29), consisting of anxiety, hysteria, and hypochondriasis among the frequent post-injury neurotic disturbances. He believes that these disorders arise largely from the psychic value of the head and from neurotic tendencies present before injury. The "post-concussion syndrome" he believes to be on an organic basis, although an intricate picture soon develops because the organically based disturbances accentuate the development of neurotic overlay.

Study of our patients had indicated that the "psychic value" of the head is an important factor in the development of neurotic disturbances. As an example it may be interesting to consider one case specifically. This patient received a moderately severe, penetrating, left parietal injury. After recovery of consciousness he was confused and disorientated. Gradually he recovered his ability to think clearly and when he was admitted to our hospital, four months later, showed no signs of mental confusion. He had developed left hemiplegia following injury, which was present at this time. The W-B indicated that he was of low superior intelligence.

After several discussions with one of the writers the patient told of the development of anxiety and lack of personal confidence following injury. He was aware of the confusion and disorientation that had been present after the injury. He had no idea how the head injury would affect his future adjustment. Perhaps due to prior misinformation, he suspected that his behavior would be peculiar and that he would not be able to recognize these peculiarities. He did not place much confidence in what the

doctors told him concerning his psychological adjustments, because he thought that they were probably withholding information, supposedly for his own good. Therefore he decided to try an experiment. He selected the patient on his ward whom he considered to be most intelligent, and began developing a close friendship with this person. After they had been with one another almost constantly for about two weeks, the patient who devised the experiment, confidentially asked the other patient if he had noticed anything peculiar about his behavior, explaining that he wanted to face the truth. He was informed that nothing queer had been noticed. Again he suspected that his feelings were being shielded. Only after a strong relationship of confidence had been developed between the patient and one of the writers, was he convinced that his behavior was not peculiar.

We have seen neurotic disturbances arise in this manner in a number of in-

stances, and feel that such disorders should be carefully guarded against and watched for in the treatment of brain injured patients.

It is important to stress the arising of a lack of personal confidence among brain injured persons. As in the specific case mentioned, they often doubt their ability to behave and think properly. There is frequently a deep-seated fear that things have changed, that they are not the persons they were before they were injured. This is reflected in anxious, cautious, guarded behavior.

In our opinion, affective disturbances following head trauma arise as a manifestation of the intricate interplay of organic and functional factors. Intellectual impairment, caused by actual destruction of cortical tissues, may be a factor eliciting neurotic disturbances. Further, it has been concluded in several other studies that a head injury may elicit or precipitate neurotic or psychotic predispositions.

III. CRITIQUE OF TESTS PREVIOUSLY USED

IN PREVIOUS studies (1, 2) the Wechsler Mental Ability Scale (Form B) (MAS), the Rorschach, Shipley-Hartford-Retreat Scale for Intellectual Impairment and the Hunt-Minnesota test for Organic Brain Damage were considered in respect to their value as diagnostic aids in the determination of brain injury. Inasmuch as these studies were of a largely quantitative nature, it is our purpose in this paper to review critically each of these tests, irrespective of its diagnostic value, considering the comparative advantages, disadvantages and rationale of each. The MAS has been discussed in preference to the more widely used W-B for the following reasons: (1) The majority of the brain injured patients had been administered the MAS; (2) The MAS was extensively used during the war but little has been reported as to its value as a diagnostic instrument; (3) The MAS and the W-B are so similar that in general the same criticisms apply, especially since the approach to be made does not take specific item differences into account.

A. THE WECHSLER MENTAL ABILITY SCALE

The MAS, although diagnostically more valuable than either the Hunt or the Shipley, had certain undesirable features which became evident when dealing with brain injured patients. Observations by the writers and others in clinical situations indicate that for a considerable period of time following the brain damage the patients fatigue rapidly when confronted with any task involving mental effort (1). The MAS, using 10 sub-tests, was found to be much too long to be used as a "one session" screening device. The reasons are obvious; excessive

fatigue would have a definite effect on future rapport and the obtained IQ or mental age would be unreliable. Several methods were tried in an attempt to offset this disadvantage. (1) The test was divided and given in two periods. However, "test splitting" is undesirable procedure. As pointed out by Rapaport (23), "when a subject takes an intelligence test, his performance represents his efficiency of functioning then and there." If the test is given in two different periods, the subject's efficiency may be at different levels, and thus introduce an added variable which cannot be adequately evaluated in interpretation. (2) A shortened form of the MAS was used. The value of this procedure will be discussed later. (3) Several short interviews were held before any actual testing began. During these periods the patient was oriented as to the purposes and values of the testing program and at the same time provided with the opportunity for establishment of a good patient-examiner relationship. However, as it was very often necessary, particularly in cases of "closed" head injury, for the neurologist to get the psychologist's opinion at once as to whether brain injury existed and some idea of the degree of impairment the pre-testing interview situation was not always a satisfactory procedure. It became apparent that some short, easy to administer, screening measure was necessary and valuable in these cases.

The second point to be discussed is that of "limited sub-test variety". We do not intend to convey the impression that the types of mental functions being sampled are limited but that the "all verbal" aspect of the first half of the measure becomes monotonous. The writer has experienced numerous in-

stances during which criticisms have been voiced and the patient has become restless, irritable, suspicious, or depressed. The solution is to present the sub-test in a different order. Although the sub-tests have been standardized individually and not on the basis of a certain sub-test sequence, the effect of a random order presentation on the reliability and validity of the measure is an open question.

Closely allied to the above point is the brain injured patient's extreme sensitivity to failure. Most of these patients have a preconceived notion as to the consequence of brain damage. Some believe that their injuries have reduced them to a state of moroncy, others, that insanity is sure to follow. These fears and the resulting anxiety have to be treated as neurotic manifestations. To the brain injured patients, all of the verbal sub-tests seem to be similar and continued inability to answer some of the items in each sub-test acts to summate their fears concerning their mental status. It is possible then to destroy rapport completely, making subsequent therapy difficult, creating an aversion to further testing, and instilling a sense of inadequacy which may extend into depression or the adoption of the "I am a complete and permanent invalid" attitude. It takes all the skill that an examiner can muster to prevent this from occurring.

A few of the patients were of the opinion that certain of the sub-tests were "kid stuff". This attitude is obviously not conducive to good rapport or to active cooperation and full effort. Generally the Block Design, Object Assembly, and Picture Arrangement sub-tests were the ones which aroused these feelings. The material used in the first and the types of objects assembled in the second appear to be the reasons for the dislike. As for the third, the difficulty arising from their

inability to grasp the appropriate relationship was expressed by calling it "a game for kids". Although the presence of such an attitude is informative since it may be an expression of personality dysfunction, it makes scatter interpretation difficult. In this respect anxiety and other neurotic trends are ever present problems. However, it is felt that such items tend to exaggerate or distort the findings and certainly lead to increased difficulty in differential diagnosis.

It has been the experience of the writers that for all the brain injured cases the extent of co-operation and effort varied from sub-test to sub-test. This was true of the controls as well, but was not as marked. Retarded mental efficiency, in conjunction with all of the factors previously mentioned, prevents adequate control of interest and effort. This motivational variance appeared to result chiefly from any or all of the following causes: (1) An expression of either a definite personality change or an exaggeration of certain aspects of the pre-injury personality. (2) An involuntary attention lag. (3) An attitude of doubt or fear occurring when the previous sub-test had been exceptionally difficult, and a number of obvious errors had been made. These factors which increase motivational variance increase the difficulty of scatter interpretation.

Inasmuch as each sub-test of the MAS has been standardized separately, the question of why a shortened form of this test was not used may arise. A short form, consisting of Vocabulary, Analogies-Similarities, Digit Symbol, and Block Design was tried, but was found to have several disadvantages: (1) the sub-test selection to comprise the short form was based on the assumption that organic brain disease and post-traumatic brain injury would be reflected in an identical man-

ner by the patients' performance on these sub-tests. This assumption was necessary because of the limited data available on post-traumatic cases. Our clinical experience with the short form indicated that it did not satisfactorily differentiate between brain injured patients and other types. This finding suggested that on the short form the performance of patients with brain injury and organic brain diseases are not directly comparable. For this reason, a complete MAS was administered to each patient. (2) As pointed out previously an estimate of a brain injured patient's level of performance is of importance. It gives a base line for the determination of subsequent improvement and, through the varied sub-tests, specific deficiencies are indicated which provide a sound basis for re-education. The MAS and Wechsler-Bellevue, being closely comparable, are excellent measures for the test-retest technique. However, if part of the MAS is given as a short form and the entire test repeated at a later date, the effect of practice on the tests previously used cannot be adequately determined. It is obviously impossible, after giving the short form to merely add the remainder of the sub-tests later. There is definite evidence that improvement does occur so that a test given in two sections at different dates would very likely not tap the same level of general ability. (3) It was found that Analogies-Similarities did not quantitatively or qualitatively differentiate the two groups. An r_{xy} between Vocabulary and Similarities was found to be .72 for both the brain injured and the controls. Inasmuch as the site of injury occasionally extended into the motor area, some patients could not take the Digit Symbol test. This meant that in some cases the diagnostic value of the short form was dependent upon the Block Design test, and as is

indicated in Table 4, the validity of this test alone is not too high.

We have already discussed the presence of neurotic or psychotic trends in the brain injured patient and have indicated the difficulty that these create in scatter interpretation. If the sub-tests of the Wechsler-Bellevue which are affected by neuroses, psychoses, and brain disease

TABLE 4
MAS sub-test validities

Test	r bis
Vocabulary	.05
Information	.08
Arithmetic	.31
Comprehension	.28
Similarities	.17
Digit Span	.19
Picture Completion	.23
Picture Arrangement	.27
Digit Symbol	.38
Object Assembly	.21
Block Design	.20

are compared, it will become apparent that at best differential diagnosis is a difficult task. It is admitted that the MAS and W-B are not identical but they are similar in content and we have findings to indicate that they yield similar results. If there are certain sub-tests which can be used to distinguish between brain injury, neurosis, and psychosis (and it is assumed that there are), the clinician faced with a brain damaged patient with neurotic or psychotic tendencies finds a differential scatter analysis extremely complicated and almost impossible.

Returning to Table 1, it is evident that the sub-test results could have been interpreted as indicating the existence of either brain injury or schizophrenia. Added was the presence of a large number of irrelevant comments, confabulations, and bizarre responses such as "a radio and a newspaper are alike because they can't be seen, can't see radio waves

or thin paper." The Rorschach was strongly suggestive of schizophrenia, including position responses, color naming, bizarre responses, contamination, and confabulation. However, the patient had sustained severe brain damage. Most of the brain injured patients gave indications of at least mild neurotic disorders and occasionally a subject's adjustment showed peculiarities resembling psychotic tendencies. Two patients included among the brain injured cases showed definite psychotic pictures, each several months after injury.

It has been our experience that the MAS draws too heavily on "old" learning to be an excellent differential measure. The ability to form new relationships and the application of the brain injured patients' present level of ability or efficiency to new situations in the important aspect to be considered. All too often the extent of previous training and the type of cultural background has prevented adequate analysis of the sub-test results. Rapaport (23) makes the following observation, "it will be shown, however, that certain deficiencies due to educational environment or assets due to cultural predilection, may cloud or exaggerate some of these diagnostically distinguishing features of impairment".

Every clinician is aware that before any psychological test is to be given it is mandatory that as much be known about the patient and his background as possible. However, if there are certain educational and cultural variables present that will influence the performance on certain sub-tests, the question of how they can be allowed for and equated arises, even if the examiner is aware of them. Frequently a moderately brain injured and occasionally a severely damaged patient's performance on the MAS was such that it was impossible to detect

the presence of any intellectual impairment. These cases referred to had minimal sub-test scatter and scores in the average range. To all appearances they were completely normal records. However, after a few minutes conversation and casual observation it became very evident that they had suffered an intellectual loss. The Rorschach showed this very clearly, many of the "signs" of post-traumatic cerebral injury being present (2). Their intellectual control was poor and their ability was not being utilized at the level that might be expected from the total MAS score. In other words, the MAS does not necessarily yield evidence as to how efficiently the indicated ability is being employed.

The final point to be discussed is the question of validity. Any psychological test, whether it be designed to sample intellect or personality, has a definite problem in the establishment of a criterion against which the measure can be validated. If the MAS is to be considered as a test of adult intellect alone it is probably as valid as any test for this purpose, but if it is to be considered as a differential measure to be used for the diagnosis of certain personality dysfunctions and the presence of organic brain disease or damage, we are faced with an entirely different problem. It would seem that brain damage should be the perfect dichotomous variable, as the pneumo-encephalogram, neurological findings, surgical reports, and the EEG should establish the existence of brain injury without question. Unfortunately all is not as simple as it appears. For example, can it be assumed that frontal, parietal, occipital or temporal injuries will all have the same behavioral residuals? Was the damage focal, diffuse, or penetrating? How much tissue was lost and how will it affect performance? These

neurological aspects alone, some of which cannot be adequately ascertained while the patient lives, are enough to indicate the difficulty involved in determining the criterion of brain injury. However, if the presence of tissue damage alone is considered adequate, there is still the problem of comparing the results of those obtained from various types of personality dysfunction. With this as a frame of reference and considering the existence of post-traumatic brain injury to be an acceptable criterion, what is the validity of each sub-test of the MAS?

The cases used were to some extent selected. There were 50 controls and 71 brain injured cases of the same average age. The former were without brain damage, considered well adjusted, and were within the normal range of intelligence. The latter group was distributed as follows: Eight cases had severe, 40 moderate, and 23 mild traumatic brain injuries. The pre-injury intelligence of the brain injured group was estimated on the basis of the "hold" tests and all available Rorschach data. Although this method is open to question all patients were considered to have been within the normal range. It is obvious that individually the sub-tests could never be depended upon to adequately determine the presence of brain damage. Actually these validities indicate that if given two groups, one with and one without brain injury, a diagnosis based on chance selection would give comparable results. These findings, of course, do not give any direct information as to what the validities would be if the sub-tests were used to differentiate brain injury from neuroses or psychoses, but the inference is that they would be even lower.

The value of the measure is not completely dependent on the use of the single sub-tests, nor from the scatter pattern

that they may form. To those who believe that the diagnostic value of the MAS consists in comparing a scatter pattern to one already established and by means of such a comparison labeling a disorder, it is suggested that approximately as valid results can be obtained by guessing. It is not intended to convey the impression that the MAS is a valueless instrument. On the contrary, it has been found to be one of the most useful. It has been employed with benefit not only for the determination of the IQ and special disabilities, but for diagnosis as well. Rapaport (24) has estimated that the Wechsler-Bellevue will be definitely diagnostic in 30-40% of the cases and indicative in 30-40% more. We have found the MAS differentially diagnostic in 40% of all types of cases and to show definite trends in an additional 30%, but only if the total behavior was considered. If the scatter pattern alone was used it was found that we could be sure in only 18% of the records and get some indication in but 20% more.

The MAS and the Wechsler-Bellevue have a distinct advantage in that they not only require a subject to say something but to do something as well. Observation of how the patient reacts to a situation, his mode of approach, how he organizes his thought, and the interest he shows, are all of the utmost importance. Through the use of Rapaport's technique of "testing the limits" the scope of both the MAS and W-B can be extensively increased. Only by adding together all the qualitative and quantitative data do these instruments function efficiently. However, the obvious corollary, a test is only as good as the person using it, still holds true. A high percentage of successful diagnosis depends upon "examiner validity", that is, on the background and experience of the clinician, not only with

the test itself but with all types of mental variants. Sometimes conclusions regarding a patient's clinical status becomes a fusion of test performance and behavioral impressions perhaps not even connected with the actual test administration. This leads to the dangerous practice of stretching the tests' limitations and creates the impression that the instrument will produce clinical data beyond its capability. Both the MAS and the W-B are fully structured and as a result the type and variety of performance is limited. They have a definite place in a battery of tests but are not to be conceived of as perfect single measures.

Some of the points discussed may appear to be the effects of an artificial war-created situation. However, a large portion of the cases included in this study received brain damage after the war period and further, those patients who were injured during combat or under combat conditions were well aware, upon hospitalization, that their tour of active duty was over. In any hospital, army or civilian, the patient is always concerned with his chances of regaining his prior state of mental or physical health; whether or not he is improving, and how long it will be before he is released from the hospital. All of these have been the primary concern of nearly every individual considered in this study.

B. THE SHIPLEY-HARTFORD RETREAT SCALE FOR INTELLECTUAL IMPAIRMENT

In a previous study (1) the Shipley was found to be of little aid in establishing the presence of brain injury. Certainly one of the most outstanding reasons for its failure to be of value lies in its structure. "The CQ [Conceptual Quotient] scale is based upon the clinico-experimental observation that in mild degrees

of mental deterioration, and in other conditions involving mental impairment, vocabulary is relatively unaffected, but the capacity for Abstract (conceptual) thinking declines rapidly" (30). Obviously if a decline in concept formation occurs in all types of psychotics, even to a limited degree, differentiation between such disease entities and traumatic damage is going to be nearly impossible. Added is the fact that there is evidence (1) that neuroses as well as psychoses affect the CQ. We are not questioning the statement that the test indicates the presence of impairment. In a previous study (1) it was found that it does. However, one can never be sure of the cause. When the conceptual quotient (CQ) is low, all that can be safely said is that impairment of some type is present.

As has been stressed, it is important in brain injury to determine specific losses in intellectual functioning. The Shipley can offer very little in this respect. The MAS, W-B and Rorschach, on the other hand, not only give certain insights in this respect but tap other functions and aspects as well. It is not enough to indicate the existence of impairment, as it leaves the questions of the type, degree, and reason for the loss unanswered. It should be noted that only the extremes of the categories listed in the Shipley manual are presented here; therefore, the percentages of any group, e.g., "severe", will not add up to 100 per cent.

In comparing two groups, one with and one without brain injury, it was found (1) that the validity of the scale, in this restricted sense, was only .25. The low validity coefficient at first was believed to be partially caused by the inclusion of a number of neurotics in the control or non-brain injured group. These cases were omitted and the biserial

validity coefficient recomputed. The new coefficient was found to be .30. This finding makes it apparent that the presence of personality variants was not alone responsible for the low validity. The CQ's of the brain injured patients were then re-plotted and the results are shown in Table 5. Forty-four per cent of the total brain injured group obtained scores in

cases tend to earn low quotients. For this reason extreme caution must be observed in interpreting quotients from individuals with vocabulary scores below 23 (14 yrs.) (30)". In addition to the possible invalidity of scores for persons of low intelligence, an occasional brain injured patient's vocabulary score has been lower than should be expected from the ob-

TABLE 5
Percentage of brain injured patients falling into certain
of Shipley's impairment ranges

CQ'S	Severe		Moderate		Mild		Total	
	N	%	N	%	N	%	N	%
Normal	1	13	8	47	15	32	24	33
Slightly Suspicious	3	38	2	12	3	6	8	11
Probably Pathological	1	13	1	6	10	21	12	17

or slightly below the normal range and only 17% received scores that were considered "probably pathological". Without considering the results of the control group, the reason for the low validity becomes apparent. A number of the brain injured cases did not suffer any demonstrable loss in the abilities required by this test. It is evident that a one aspect measure will not establish the presence of organic brain damage in every case. It is also interesting to note that some of the brain injured patients, especially in the mild category, did not give an "organic" record on either the MAS or the Rorschach but did exhibit definite neurotic trends. The low CQ's in these cases may well be due to personality disturbances. If this is true, the validity of the scale, in a differential sense, is probably even lower.

The Shipley is also limited in that, "the available evidence indicates that CQ's obtained from sub-normals are not valid. Feeble-mindedness and borderline

tained IQ or MA on a Wechsler-Bellevue or MAS. Such instances have been rare in our experience but have occurred. This indicated a source of additional cases for whom the Shipley cannot be used, inasmuch as each of these CQ's has had to be considered invalid.

Any self-administering test has certain advantages and disadvantages that are evident to every clinician. However, certain of the disadvantages become more apparent when dealing with the brain injured patient. An impersonal relationship does little to establish confidence and trust in the psychologist. If the Shipley is used as a screening device, regardless of how the test situation is handled, little actual patient-examiner relationship is gained. Thus little opportunity is provided for the establishment of rapport which would be valuable in further testing. Of course this disadvantage can be offset by holding a few interviews or giving other tests before the Shipley is used, but, as has already been indicated,

its use as a screening device is the only possible way in which it can profitably be employed.

We have noticed, as has Shipley (30), that some patients fail to comprehend the directions, but more important are those instances in which the subject does not care to admit his lack of understanding or has little interest and motivation. Each of these situations can often be remedied by good rapport.

Finally the Shipley is so structured that little if any behavior is exhibited that has clinical significance. The test does have certain advantages: (1) It is very short, (2) it can be administered in groups, and (3) if the interest is to determine the presence or absence of intellectual impairment, regardless of its cause, the test is of value.

C. THE HUNT-MINNESOTA TEST FOR ORGANIC BRAIN DAMAGE

In general the Hunt-Minnesota test for Organic Brain Damage may be criticised on the same basis as the Shipley-Hartford Retreat Scale. The test is one of limited aspect. It is true that there are a number of interpolated tests but the scoring standards for these are so generous that they are of little or no value. It is our opinion that these tests may have more diagnostic value than the T score if the scoring were revised.

The ever present problem of validity must also be considered. The results obtained in a previous study (1) indicate clearly that, as far as post-traumatic brain injury is concerned, the test cannot be relied upon to adequately detect the presence of brain injury. It is interesting to note that the r_{xy} obtained between the Shipley and the Hunt was only .263 which was not significant at the 5% level of confidence. Certainly it is to be expected that two tests, both supposedly

measuring impairment, will have a correlation coefficient that is at least significantly greater than zero. In addition there is nothing in the manual or in Hunt's article describing the test (13, 14) to indicate that the T score may not be raised by neurotic difficulties in patients.

The use of interpolated tests or material is questionable procedure, inasmuch as the possible presence of inhibition or confusion is a variable that has not been checked experimentally. Some definite results should be presented on this point before this technique is to be considered an acceptable testing method.

In general, we have not found the test to be stimulating to the brain injured patient. This factor made it difficult in a number of cases to maintain motivation and prevent unconscious or conscious malingering.

As with the Shipley, the structure of the test prevents the manifestation of much diagnostically valuable overt behavior. This largely deprives the tester of the opportunity of observing methods of approach and the mechanics of problem solving which are so apparent in the Wechsler-Bellevue or the MAS.

Our experience and evaluation of the Hunt indicates that it contributes little to the understanding of the brain injured patient, whether used individually or as a part of a battery (1).

D. THE RORSCHACH TEST

In a previous study (2) we have proposed, described and evaluated various specific signs which may be indications of organic cerebral alteration. The Rorschach records and behavioral signs given during the test administration were compared in an experimental group of 60 brain injured patients and a control group of 100 hospital patients without brain injury. The ten signs of organic

brain injury that Piotrowski has previously postulated (22) were investigated, and five of them were found to be of value in differentiating between post-traumatic brain injured and control patients. In addition, nine new signs were studied, and their value indicated. We would now like to consider the signs found to be helpful, not in connection with the comparative frequency of their occurrence in brain injured and control groups, but in respect to the reasons why these signs occur more frequently among patients with organic cerebral alteration than among controls.

Of the ten signs previously pointed out by Piotrowski (22), Impotence, Perplexity, Automatic Phrases, Repetition and Color Naming were found to be of value in differentiating between the post-traumatic brain injured patients and the controls (2). A considerably higher number of neurotics were included in the control group than would have been obtained through testing a general run of hospitalized patients, inasmuch as many were referred for examination because of suspected neurotic disturbances. The ideal situation would have been to compare the Rorschach records of the post-traumatic group with normals and with clear cut groups from each of the neurotic and psychotic classifications, in order to establish definitely the value of proposed findings in differential diagnosis. This, however, was impossible in the situation in which the study was done. Some practical value may be present in the approach that was made inasmuch as the results indicate that Rorschach findings frequently differentiate post-traumatic brain injured patients from patients hospitalized primarily for other physical disorders.

Nine other signs, named, described and evaluated in the study referred to

(2), are also of definite assistance in determining the presence of cerebral deficit. Although it is of some value to obtain indications of the presence or absence of cerebral deficit, in traumatic cases this question is often answered by surgeon's reports, pneumoencephalography, or other neurological findings. We believe that the principal aim of psychological testing in these cases should be to evaluate possible intellectual impairment and information regarding the psychic adjustment of the individual to the trauma. Therefore we ask the questions, why do these signs occur more frequently in post-traumatic brain injured than in control patients? What are the dynamic personality mechanisms, either intellectual or affective, that cause these signs to be presented?

Although we have noticed certain personality factors that may account for the presence of some of the signs of post-traumatic cerebral deficit, factors not noticed by us may also play a definite part. The interplay of both intellectual and affective disturbances is probably present as a cause of the manifestations of most of the signs. In our opinion some of the signs are shown as emotional reactions to the recognition of impairment in intellectual functioning. Other signs probably represent characteristic techniques or behavioral patterns adopted by brain injured patients to overcome the frustration arising from performance they judge to be unsatisfactory. Still other signs seem to be primarily intellectual in nature. It has been found that the intellectual level of the patient will affect the signs of cerebral injury given (3). We have been unable to incorporate indications of personality maladjustment such as anxiety, hysteria, depressive tendencies, or hypochondriasis into the diagnostic pattern of brain injury, inasmuch

as we have been unable to determine characteristic differences in these Rorschach indications given by brain injured patients and neurotics without brain injury.

✓ Impotence is defined by Piotrowski as the patient's recognition of the inadequacy of a response with the inability to either withdraw or improve it. This sign is probably related to the intellectual impairment often present following traumatic brain injury and also to the adjustment of the individual following injury. Specifically, this seems to be a manifestation of the deep feeling of uncertainty and lack of personal confidence which we have seen in many of these cases. The headaches, confusion, dizziness, retardation of thought, and other organically determined symptoms usually following severe head trauma probably contribute to the patient's lack of personal confidence. The patient feels that he must give some responses, but he is not sure whether he is behaving properly. He does not know if his post-injury behavior is revealing peculiarities unknown to himself. Therefore he gives responses, doubts their adequacy, but is unable to withdraw or improve them because he does not know what to give in their place.

✓ Perplexity, or the subject's distrust of his own ability and a request for assurance, seems to be very similar to Impotence in regard to the reason for its manifestation. It, too, probably springs from a lack of personal confidence which may well have been accentuated by the subject's recognition of temporary or permanent impairment in intellectual functioning. As previously mentioned, the "psychic value" of the head has been noted in many cases as an additional factor in the development of personal uncertainty.

✓ Automatic phrases, or the use of a

stereotyped phrase in an indiscriminate fashion in more than half of the cards, and Repetition, or the occurrence of similar responses at least three times in a record without regard for form, probably represent intellectual peculiarities frequently found in brain injured persons. Possibly these types of behavior arise because they represent easy ways to complete the test—a tendency to follow the path of least resistance. Observations and questioning indicate that these signs are given without the patient's awareness. They do not intentionally resort to these methods in order to make the task easier.

At least one occurrence of Color Naming has been considered a particularly important sign in cases with organic intracranial pathology (16), but in our study of post-traumatic brain injured cases, it was somewhat less important. Kelley considers color naming an indication of "... the confusion of the patients in relation to the environment and represents the emotional lability and instability which occurs so often".

Consideration of the Ink-blot as Representations of Actual Objects, Concrete Responses, and Inflexibility or the inability to use any part of any of the ten figures for more than on association, are signs which are closely allied with the type of impairment discussed by Goldstein when he considers the inability of brain injured to assume the abstract attitude (9).

Consideration of the Blots as Actual Objects springs from the brain injured patients' dependence for association upon concrete stimuli. An extreme form of this type of behavior is extensively described and discussed by Hanfmann, Ovsiankia, and Goldstein (12). This patient often spoke to persons in pictures, failing to recognize that they were not actual people. The sign Concrete Responses,

scored when a record gave no indication of association involving the quality or attributes of responses, is obviously related to a lack of the assumption of the abstract attitude. We do not suggest that this sign necessarily represents an impairment in the ability to assume an abstract attitude, but it has been found much more frequently among brain injured patients than controls. Inflexibility has been noted by various writers, using a number of experimental procedures, as the brain injured patient's inability to shift. This behavior is also considered to be a manifestation of inability to assume the abstract attitude. Kelley (16) quotes Bolles and Goldstein to substantiate this position, "He (brain injured patient) is unable to shift from one type of attitude to another voluntarily". This voluntary shifting according to Goldstein, presupposes the capacity for the abstract attitude or categorical behavior. Weigl also studied this phenomenon and verified the findings of Goldstein, believing that the normal could classify on various bases, whereas the brain injured patient once having adopted a specific classification could not shift to another. Kelley concludes, "this inability of the patient to shift his concepts even though an obviously good form is offered (suggested by the examiner) seems to be definite indication of the impairment of abstract behavior. If present it points almost pathognomically to organic intracranial damage or to a schizophrenic process". It must be noted that Kelley elicits this sign by suggesting alternative responses to the patient during the "testing the limits" period. It may be inferred from the previously given definition of our sign, Inflexibility, that it is determined by scrutiny of the responses given during the test period.

Unclear definitions of responses had

been found to be one of the most helpful signs in differentiating between post-traumatic brain injured and control patients (2). It is probably primarily a manifestation of the intellectual impairment suffered by many patients with organic cerebral deficit. Its principal difficulty in practical use is that judgment of its presence is largely based on subjective consideration, and thus its value relies heavily upon the experience of the examiner.

The personality mechanisms giving rise to the sign Edging are in doubt. Beck states that in his experience edging is exclusive schizophrenic behavior, but we have noted it in 41.6 per cent of a group of 60 brain injured patients and in 17 per cent of a group of 100 control patients including neurotics (6). Beck explains the sign among schizophrenics by saying that it "... is simply another peculiarity with which these patients react to stimuli and handle their problems. How much it projects a captious caution, alien to normal procedure, and how much it is odd posturing, I am not ready to say" (6).

Irrelevant comments, or the expression of a statement during the testing situation which is not in any noticeable way pertinent to the test, has been observed in patients with brain injury. This sign may be factors basic to this distractibility of the brain damaged patient, which has been discussed by Goldstein (8). Impairment in attention and concentration may be factors basic to this distractibility. In addition, it is entirely possible that this behavior may be partially caused by the patient's desire to escape the testing situation at least temporarily; a situation which accentuates the lack of self-confidence which has been seen in a large percentage of brain injured patients.

Covers Parts of Cards and Withdrawal and Re-attack are signs that also have been noted. The first occurs when the patient excludes part of the ink-blot from his vision with his hands. The second is present when a subject voluntarily removes his attention from a card, perhaps turning the card over or looking in another direction, and suddenly renews his scrutiny. We believe that these signs are behavioral patterns which spring from a recognition of inadequate performance and thus permit the patient to escape a more distinct recognition of inadequacy with more intense feelings of frustration. Other factors are probably also involved. Covering parts of the cards may be an attempt to combat distractibility by excluding stimuli other than those selected for immediate scrutiny and concentration. Withdrawal and Re-attack may be partially an attempt to get a new view of the situation, a different mental set. In this respect it is related to the "inability to shift" seen in certain of the sub-tests of the screening device presented later in the paper.

Catastrophic Reaction is a sign which probably represents the failure of many of the signs, previously discussed, in meeting the patient's attempt to escape frustration. Many of the other signs were explained, at least in part, as mechanisms used to satisfy the deep feeling of personal inadequacy, accentuated by recognized intellectual impairment, in many brain injured persons. Our observation has indicated that these other signs are first shown by the patient and when a catastrophic reaction occurs, it is a culmination of growing feelings of frustration which could not be averted by expression of the other signs. The fact that Catastrophic Reaction was found in 31.7 per cent of the brain injured and

only 1 per cent of the controls, and further that 73 per cent of the severely injured showed this sign, substantiates this theory. It is to be expected that fewer brain injured patients would manifest catastrophic reactions than the other related signs. The other types of behavior are used first, but when the test progresses and these are not satisfactory, it is necessary to make a frank admission of frustration by engaging in a catastrophic reaction. It should be mentioned that Goldstein (8) has described and discussed these reactions arising among brain injured persons in other situations.

We must emphasize that the Rorschach signs shown by the post-traumatic are not necessarily restricted to this group. A previous study has shown that they occur much more frequently among the brain injured than in a control group of hospitalized patients, including many neurotics but no one with central nervous system disorder (2). However, it is quite possible that psychic dynamisms in many persons could cause the manifestation of at least some of these signs. The actual value of these signs in differential diagnosis can be determined only when controlled studies have been made comparing post-traumatic brain injured cases with selected groups of persons with various psychotic and neurotic disorders.

In our previous study it was possible to detect indications of typical "organic brain injury" manifestations by use of the Rorschach in a high percentage of the patients with post-traumatic cerebral injury. In the experimental group 70 per cent were considered as "definitely brain injured" and 14 per cent were evaluated as showing "significant indications of brain injury". Although most of the remaining 16 per cent gave at least one of the signs we have found to be typical,

the signs were not present in sufficient quantity or degrees of intensity to justify consideration as significant.

It will be of interest to consider the basis on which the classifications of "definite brain injury" and "significant indication of brain injury" were assigned. In our opinion, a procedure of merely counting the number of signs present (3) will not give satisfactory results. Undoubtedly some cases would be correctly classified if this method were followed, but further considerations are necessary for more accurate work. We have found three points to be most important: (1) The intelligence level of the subject; (2) the number of signs present; and (3) the intensity of these signs. The intelligence level is important because the number of signs present has been found to decrease as the intelligence level increases (3). The absolute number of signs given must, of course, be considered in regard to their experimentally determined significance in differentiating between brain injured and control patients (2). The intensity with which the signs are given can best be evaluated only after considerable experience with these patients. This point should not be disregarded (although the weight placed on these judgments must be determined by the experience of the tester), because it has been found to be of definite clinical value. Some brain injured patients give relatively few signs, but the great intensity often justifies assumption of the presence of brain damage.

It is also sometimes of verifying value

to consider the results of other tests and the past history of the patient in attempting to determine if the level of performance indicated by the Rorschach roughly agrees. It is, of course, hazardous to base conclusions on this comparison alone. Certain neurotic tendencies, viz., anxiety, hypochondriasis, and depression, are frequently indicated by the Rorschach in cases of brain injury. However, we have found no way in which these indications in themselves differ from those given by neurotics without brain injury.

A brief evaluation of the Rorschach will be made in comparison to the Wechsler-Bellevue, MAS, Shipley and the Hunt. Our studies have indicated that the presence of organic cerebral alteration is more frequently indicated by the Rorschach than by the other tests mentioned. Obviously this is due to its ability to tap areas of possible impairment beyond the scope of the other tests. It has certain disadvantages such as its length and its appearance. Even in the hand of a skilled examiner, the test tends to arouse suspicion, which in all probability arises from its unstructured nature. Perhaps the greatest drawback to its use lies in the degree of interpretative skill necessary which comes only with extensive experience and training. The test is also open to the same fault as the MAS or W-B in that the limits of the test can be exceeded. To be sure it is the best single measure that we have used for the purpose of detecting brain injury; however, it functions most efficiently when it is used as a part of a battery.

IV. REQUIREMENTS FOR A SCREENING TEST

FROM the discussion of the MAS, Shipley, Hunt and the Rorschach it is apparent that a screening device would be a valuable addition to a battery of tests to be used with brain damaged patients. It would eliminate the frequent problem of the need for quick diagnostic aid and at the same time provide landmarks for further testing. To do this efficiently certain prerequisites must be met. The following, although not all inclusive, are certainly basic.

1. *The measure must be short.*—This prevents fatigue and assures good rapport as short interviews can be held both before and after the test without prolonging the initial meeting.

2. *Interesting.*—It is essential to determine the presence or absence of mental impairment. If this evaluation is to be reliable and valid, the tests must catch and hold the interest of every patient.

3. *Easy.*—It is understood that a perfect measure would be one on which neither a zero nor a perfect score could be obtained. This is difficult to attain as included in the frame of reference must be the consideration that every brain injured case must experience success. In addition, this success must be apparent to him. The habit of saying, "good", "fine", or "you did well on that one", does not suffice. In fact, constant repetition of those phrases in the face of actual or suspected failure may induce suspicion and result in the patient's loss of confidence in the examiner. The test as a whole has to be easy, as some brain injured patients experience a definite loss in mental efficiency. As a consequence, a test which is satisfactory for patients with definite intellectual loss, might not be adequate in cases of mild or only suspected injury. Conversely, test which

operates efficiently for cases of suspected injury might be too difficult for persons with severe cerebral disturbances. This can be compensated for by using only sub-tests which are of exceptional interest, allowing added time, and skillfully giving a few hints in the event of initial failure. If this procedure is accomplished with care the patient will look upon the added help as part of the test and will consider the solution his own.

4. *Relatively unaffected by neurotic trends.*—As has been pointed out, the diagnostic value of any measure is dependent upon its ability to present a clear cut differential picture.

5. *Sample those functions that seem to suffer most as a result of brain injury.*—If there are certain abilities which are usually impaired by brain damage, and if these can be isolated, it would then be possible to construct an experimental differential measure. As indicated by Wechsler (32) and in our previous study (1) it appears that certain intellectual functions have suffered more than others. These findings did not apply to every case of brain injury but were based on the mean scores of the total group. Using these results as guides, a test to be discussed in detail later, has been assembled.

6. *Understandability.*—By this is meant the development of a feeling, on the part of the patient, that the test being given is appropriate. Most of the subjects form opinions, right or wrong, as to what the test is testing. If a possible reason for a particular item is not apparent they become suspicious as to its purpose and usually express these feelings in such statements as, "I don't see how this will help me to get any better". It is neither feasible nor good technique to explain each test in advance. If the

items can appear appropriate, irrespective of their underlying purpose, it is a distinct advantage in establishing and maintaining rapport and also has a definite therapeutic effect. The patient feels that the entire procedure is aimed at discovering aids to alleviate his particular difficulty.

7. *Have a minimum dependence on previously learned material.*—This has already been discussed in detail. However, a fundamental consideration is the ability of the patients to form new relationships and to apply their present level of ability to new situations.

8. *Performance items should be included.*—This insures an adequate sample of the patient's total behavior.

9. *Validity.*—The examiner should have data available which indicates the degree to which the test can be relied on to measure what it is intended to measure.

10. *The test should be reliable.*

11. *Directions should be simple, clear and easily understood.*

12. *All performance tests should be of such nature that they can be accomplished by gross muscular movements.*—

We have encountered a number of instances when it became difficult to interpret scores from such tests as the Digit Symbol. To do well on this test fine precise muscular movements are required and if the injury is diffuse it is possible that motor area involvement may have a definite effect on the performance. That is, an added variable has been introduced, the presence and degree of effect of which cannot be readily determined. In addition there are a number of instances where the ability to employ gross movements has remained unimpaired while more specific movements have been destroyed.

V. PROPOSED SCREENING TEST

A. METHODS AND PROCEDURE

THE FINDINGS obtained from a comparison of MAS results from a group of brain injured with a group of controls (1) can be divided roughly into two general classifications; those that appeared to be definite, and those that were suggestive. The former were considered to be losses in; (1) analysis and synthesis, (2) ability to shift, and (3) ability to learn. The latter category included losses in (1) ability to integrate two points of view or to perceive a double relationship, (2) ability to plan ahead, (3) ability to anticipate, (4) ability to stick to a point. (This loss seemed to hinge upon the continuity and organization of the patient's thinking and approach), (5) definite perseverative trends, and (6) possible memory defect. In order to (a) check these findings, (b) study the capabilities of the brain injured patient further, and (c) attempt to construct a workable valid screening device for the detection of brain injury, a five item test was assembled. Each of these sub-tests were considered from a dual standpoint. First, did they individually and collectively satisfy the previously discussed criteria for the adequate screening device? Second, did they test those intellectual functions which had been thought to be definitely vulnerable and even more important, to sample those which were considered questionable? None of the items adopted are original. Three of them are parts of the Army Individual Test (4), which has not yet been released for civilian use. Each item will be discussed in regard to structure and administration (including scoring).

B. CASE MATERIAL

The brain injured group consisted of 44 patients who were known to have

sustained cerebral damage. The evidence was derived largely from surgeons' reports. In the instances where these were lacking, positive pneumo-encephalograms and/or neurological findings were available. The source of these injuries ranged from high velocity missiles to auto accidents. In regard to the severity and type of injury the neurologist distributed the

TABLE 6
Post-injury intelligence level of the
brain injured group

Intelligence Quotients	Brain Injured Group	
	N	Per Cent
75- 79	6	14
80- 89	11	25
90-109	24	54
Over 1000	3	7

44 cases as follows: 11 severe, 21 moderate, and 12 mild; 9 were considered to have focal lesions, 17 were classed as focal-diffuse and 18 were diffuse. The pre-injury intellect of these patients was determined by the previously described method; 18 per cent were dull normal, 66 per cent average and 16 per cent above average. The present level of capability was determined by the use of the MAS. The distribution of the total scores or IQ's is shown in Table 6. As had already been indicated the IQ does not indicate the true intellectual status of these patients and should be interpreted with caution.

The control group was composed of two sub-divisions, normal and neurotic. The former (N = 45) consisted of hospital attendants considered to be well adjusted, within the normal range of intelligence, and had neither received a head injury nor had record of any type of disease that might have resulted in intracranial pathology. The latter (N = 16) was a group of patients with mild

affective states, all of whom had just started to undergo psychotherapy at the time of testing. None of them had a his-

TABLE 7
Site of the trauma

Area	Brain Injured Group	
	N	Per Cent
Frontal (left or right)	10	22.7
Frontal-temporal (left or right)	1	2.3
Parietal (left or right)	5	11.4
Parietal (vertex)	1	2.3
Temporal (left or right)	2	4.5
Temporal-parietal (left or right)	6	13.6
Occipital (left or right)	3	6.8
Occipital-temporal (left or right)	1	2.3
Occipital-parietal (left or right)	10	22.7
Left frontal-left parietal (penetrating)	1	2.3
Right occipital-right frontal (penetrating)	1	2.3
Generalized	3	6.8

tory of head injury and all were within the normal range of intelligence. The intelligence breakdown was as follows: 15% were dull normal, 65% average, and 20% were above average.

Because the samples are small, each group will be described as fully as

possible to determine the existence of any outstanding differences that might account for the obtained quantitative and qualitative results to be discussed later. The composition of the brain injured group, from the standpoint of the site of the trauma is summarized in Table 7.

The question may arise as to the possible effect of aphasic disturbances on the obtained test results. The brain damaged group included only two cases with a history of such disorders. Both were excluded from the obtained results to determine their effect on the final "t" values. In every case their exclusion tended to slightly increase the obtained differences.

Inter-group comparisons have also been made on the basis of age, level of education, and pre-injury occupation. From each of these aspects the two groups do not appear to have any outstanding differences.

Finally all of the brain damaged cases received their injuries at least six months prior to testing. Accordingly, any differences that may be found are not the result of a transitory condition but reflect

TABLE 8
Age and education distributions

	Brain Injured Cases		Neurotics		Normals		Total Controls	
Educational Level								
Levels	N	%	N	%	N	%	N	%
Below Eighth Grade	1	2.3			1	2.9	1	2.0
Eighth Grade	10	22.7	3	18.8	9	25.7	12	23.5
Ninth to Eleventh Grade	14	31.8			5	14.3	5	9.8
High School Graduate	15	34.0	7	43.8	13	37.1	20	39.2
College Level	4	9.1	6	37.5	7	20.0	13	25.5
Age Level								
Below 19 Years of Age	3	6.8	1	6.3	1	2.9	2	3.9
20-24 Years of Age	14	31.8	7	43.8	13	37.1	20	39.2
25-29 Years of Age	15	34.0	2	12.5	8	22.9	10	19.6
30-34 Years of Age	3	6.8	2	12.5	5	14.3	7	13.7
Over 35 Years of Age	9	20.5	4	25.0	8	22.9	12	23.5

relatively permanent residuals of the injury.

C. RESULTS

1. Memory Tests

The sub-tests to be discussed are presented in actual testing order.

The first to be considered is a test of memory. This type of item was included

levels (31). It is, omitting articles and conjunctions, a 67-word story of a military nature. The content is well organized, cohesive, and interesting. Proper names, distances, times, directions, etc., are included but there is no part or section that introduces the principle of "isolation".

The directions are simple. The subject

TABLE 9
Occupational distribution

Occupations	Brain Injured Cases		Controls	
	N	%	N	%
Architect ✓	1	2.3		
§ Baker			2	3.9
§ Carpenter			2	3.9
Clerk	1	2.3	4	7.8
Dentist ✓			1	2.0
Farmer	9	20.5	4	7.8
Hotel Manager §	1	2.3		
Laborer	14	31.8	14	27.5
§ Lithographer			1	2.0
Machine Operator	6	13.6		
Mechanic (auto)	5	11.4	4	7.8
Musician ✓	1	2.3		
§ Salesman			5	9.8
Student	5	11.4	11	21.6
Teacher ✓			2	3.9
§ Welder	1	2.3	1	2.0

for two reasons; (1) A number of the patients indicated that their ability to retain and recall had been altered by the injury sustained. The nature of these complaints ranged from memory lapses such as forgetting to mail a letter, to the inability to recall what had just been read or heard. (2) The MAS, like the W-B, does not have a direct memory test. As pointed out by Rapaport "... the most serious shortcoming of the Bellevue Scale is the fact that it contains no sub-test which tests memory function in a more direct way than the information sub-test" (23).

The item is similar to those used in the Terman and Merrill revision of the Stanford-Binet at the X year and SA II

is told that something is going to be read and that when it is finished he is to tell the examiner all that he can remember about it in his own words. Just prior to the reading, there are the usual cautions to insure the patient's attention. The selection is then read. Care is taken to be sure that the reading rate, for the entire selection, falls between 35 and 40 seconds for every subject. The examiner should avoid a bored or affected tone and obviously emphasis should not be placed on names, distances, directions, etc. Scoring is similar to that used in the Binet. On the score sheet the story has been broken down into nearly equal thirds. Every third includes ten "memories" with the exception of the last. These are checked

by the examiner as they are related. A degree of leeway is allowed. That is, if the patient has expressed the essential element of a "memory" but the wording is not identical, credit is given. However, dates, times, distances, directions, names, etc., have to be absolutely accurate to obtain credit. Following the free associ-

disorders of form and organization of thought such as circumstantiality, blocking, impoverished thinking, perseveration, rambling, pseudo-profundity, and confabulation. Also variations in the rate and progression of the stream of thought can be detected. In short, the item can be evaluated quantitatively and qualita-

TABLE 10
Distribution constants obtained in quantitative analysis of the memory test

	Brain Injured		Neurotics		Normals		Total Controls	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.
1st 1/3 Free Association	3.66	2.00	5.56	2.15	5.20	1.89	5.31	1.99
2nd 1/3 Free Association	2.91	2.20	4.94	2.41	4.80	2.12	4.84	2.22
3rd 1/3 Free Association	2.95	1.92	4.19	1.81	4.89	1.60	4.67	1.70
Total Free Association	9.52	4.86	14.69	4.74	14.89	4.25	14.82	4.41
Questions	6.86	3.37	9.25	2.33	9.54	2.30	9.45	2.31
Total Memory Score	16.39	7.82	23.94	6.24	24.43	6.04	24.27	6.11

ation period, a series of seven questions are asked. These require specific information about the story, and the answers must be perfect. The total score is a total of credits received for the free association and the direct questioning.

This type of memory item was chosen for the following reasons; (1) it is a test of memory for meaningful material. (2) It gives the clinician a glimpse of the patient's ability to organize this type of material into a unified, integrated whole. There is a definite possibility for analysis from this viewpoint; i.e., are the "memories" disorganized and given in a random order or is the organization factor so compelling that only the bare outlines are given and the details ignored? (3) Much rich data may be obtained from this type of test. The associations that are aroused may be definite therapeutic leads. It has occasionally happened that the patient's reproduction has given a definite clue as to the cause of his affective disorder. The test also has been found to be fairly sensitive to certain

tively. In discussing each of the sub-tests the quantitative aspect will be considered first.

The data obtained from the memory test has been subdivided in such a manner that the results from the free association and the questions have been considered separately as well as in combination (total score). In Table 10 the distribution constants for each group are given. As is indicated, the free association data has been divided into thirds. This was done to determine whether such factors as primacy and recency operated in the same manner for each of three groups. It is apparent that more was retained of the first and final thirds than of the intervening section. This held for all three groups and the ratio in each case was virtually identical. It may be well to point out that although the mean of the final third of each group was approximately the same as that for the middle section, it contained one less "memory" than either the first or second subdivision. It was prorated on this basis

and the resultant mean was found to be higher than that for the middle section.

The percentage of the brain injured and control patients correctly answering

for comparative purposes. As is indicated by the control-brain injured group comparison, the obtained variance was highly significant from a quantitative standpoint. However, when dealing with

TABLE 11
Percentage of the brain injured and control patients
answering the questions correctly

Questions	Brain Injured		Controls		Diff.	D/S.D. Diff.
	N	%	N	%		
1	19	43	32	63	20	1.98
2	38	86*	51	100	14	2.69
3	25	57	40	78	21	2.21
4	11	25	33	65	40	4.26
5	11	25	21	41	16	1.68
6	8	18	14	27	9	1.06
7	34	77*	51	100	23	3.65

each of the seven questions is given in Table 11. The percentage differences obtained consistently favor the controls and are either clearly significant or indicate definite trends in all but two in-

groups as small as have been used in this study it is necessary to determine whether the means that have been obtained are good measures of central tendency. That is, it is possible that the

TABLE 12
Significance of mean differences

	Neurotics vs. Normals		Controls vs. Brain Injured	
	Diff.	"t"	Diff.	"t"
1st 1/2 Free Association	.36	.59	1.65	4.00
2nd 1/2 Free Association	.14	.20	1.93	4.14
3rd 1/2 Free Association	.70	1.36	1.71	4.58
Total Free Association	.20	.15	5.30	5.53
Questions	.29	.41	2.59	4.38
Total Memory Score	.49	.26	7.89	5.48

stances. In these cases the questions are evidently too difficult to be discriminatory.

Significance of the mean differences was computed and the results are given in Table 12. The neurotics and normals do not appear to differ in any respect. Although this was suggested by their means, it was considered best to make this test before the two groups were combined into the control group and used

averages have been affected by the presence of a few extremely low or high scores. To check this possibility the total memory test raw scores were plotted and the results are shown graphically in Figure 1. Unquestionably a bimodal curve has resulted and in general the scores appear to be well distributed in each of the two groups.

One other fact of interest can be readily derived from the graph. A number of

the brain injured patients obtained scores near or above the average of the control group and the converse situation is also true. It is apparent that given a total test score it would be impossible to classify every patient as brain injured or

scores. Upon first consideration, a zero score would seem to be nearly impossible provided the subject was making an effort. However, the examiner had known these patients for a considerable period of time prior to testing, and excellent

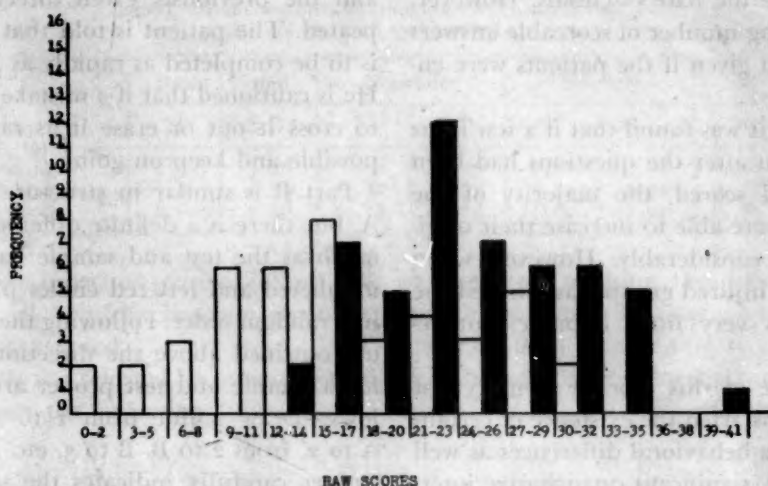


FIG. 1. Graphic distribution of total memory raw scores for the brain injured and control groups.
Key: Solid Columns = Controls

not brain injured with a satisfactory degree of certainty.

Qualitatively the test was productive. Four of the brain injured cases during the free association period gave stories that bore little relationship to the one that was read to them. However, they retained enough of the original story to receive some credit. In every instance the confabulation had a central idea or theme and was fairly coherent and cohesive, but in each instance elements of circumstantiality, preservation, and pseudo-profundity were present. When asked the series of questions, three patients became indignant and asked how they were expected to answer questions about something that had not been read to them. A fourth person gave answers to each question, none of which were related to either the original story or his version of it. Three others received zero

rapport had been established. None of them were excessively concerned over their failure, having previously experienced such lapses of memory since their injury. After inquiry it was found that other patients had noted their difficulty, especially in connection with radio programs. If a play or a dramatized current event were being presented, these patients would forget characters and also events that had occurred earlier in the program. They often became hopelessly confused and continually asked others for information about what had previously happened, or who a character was and how they were connected with the story. At the other extreme, three of the brain injured patients obtaining the highest scores did not confine their efforts to repeating the content of the original story but embellished it to the point of giving a partial life history of every char-

acter involved, what occurred before the story started and what happened after its completion. Other brain injured patients exhibited a condition which approximated impoverished thinking or brevity of associations. Their reproductions were the bare essentials. However, a surprising number of scoreable answers were often given if the patients were encouraged.

Finally it was found that if a few hints were given after the questions had been asked and scored, the majority of the controls were able to increase their original score considerably. However, when the brain injured group was allowed the same aids very little improvement resulted.

The use of this type of memory test has demonstrated the existence of certain qualitative behavioral differences as well as a highly significant quantitative intergroup score variance. The degree to which the former is characteristic of brain damage and the validity of the latter will be discussed later in the paper.

II. Trail Making Test

The second sub-test has two parts (A and B). Part A consists of a sheet of paper on which there is printed a series of circles. In the center of each of these is a number, with a range for the test proper from 1-25, and for the sample which is on the opposite side of the page, from 1-7. These circles are spatially arranged in a random order. The patient is given a pencil and the test is placed, sample side up, in front of him. The examiner then tells the subject that his task will be to draw a line from 1 to 2, from 2 to 3, from 3 to 4 and so on, in order, until the end is reached. Each numbered circle is pointed out as it is referred to, but an imaginary line from

point to point should not be traced with either a finger or pencil. The subject then performs the task for the sample, which gives ample indication of whether or not the directions have been comprehended. The paper is then turned over and the previously given directions repeated. The patient is told that the test is to be completed as rapidly as possible. He is cautioned that if a mistake is made to cross it out or erase it as rapidly as possible and keep on going.

Part B is similar in structure to Part A, but there is a definite difference inasmuch as the test and sample have both numbered and lettered circles presented in a random order. Following the procedure outlined above the directions given for a sample and test proper are as follows;—Draw a line from 1 to A, from A to 2, from 2 to B, B to 3, etc. The examiner carefully indicates the sequence of number-letter, number-letter to the patient. Again care is taken to point to each circle but not to trace a line with a finger or pencil. After the sample has been satisfactorily completed, the page is turned over. The directions are repeated, and the patient is told to work as rapidly as possible and if any error is made to cross it out or erase it as quickly as possible and to continue.

When administering the Army Individual Test the examiner removed either part of this test when the patient, after making an error, does not notice and correct it before he has proceeded beyond three more circles (4). This procedure has been altered. As the item in this instance is being used to study the effects of brain injury, all possible behavioral data was collected. In every case the patient was allowed to complete the test. It was of interest, for example, to see how often the sequence in Part B of number-letter would be lost. Therefore after the

test had been failed according to the criterion above, the patient was encouraged and the number-letter relationship re-established. It was also felt that remov-

ever, there may be a carry-over effect from Part A, which required only a number to number sequence. If the subject is rigid, perseverative, or unable to shift,

TABLE 13
Distribution constants obtained in quantitative analysis
of the trail making test

	Brain Injured		Neurotics		Normals		Total Control	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Trail Making A	6.93	3.26	9.56	.79	9.86	.68	9.76	.73
Trail Making B	1.86	2.08	5.56	2.50	6.03	2.75	5.88	2.68
Total Score	8.80	4.66	15.13	2.85	15.89	2.97	15.65	2.96

ing the test increased sense of failure and inadequacy, which in our opinion, should be avoided.

The test was selected because it seemed to measure the following functions: (1)

it is easy to envision the difficulty that will be involved. However, after failure on Part B, it is necessary to determine whether or not the subject actually knows the sequence of letters in the alphabet

TABLE 14
Significance of mean differences

	Normals vs. Neurotics		Controls vs. Brain Injured	
	Diff.	"t"	Diff.	"t"
Trail Making A	.30	1.34	2.83	5.99
Trail Making B	.47	.57	4.02	8.00
Total Score	.76	.84	6.85	8.62

Ability to perceive a double relationship, (2) Ability to plan, (3) Ability to "shift", and (4) Related to the preceding point, the presence of any perseverative tendency.

In order to do well on the test it is necessary always to look ahead, and before the test is started, to form a quick over-all plan. The subject who draws a line from 1 to 2, on reaching 2 begins looking for 3, and repeats this procedure over and over will do rather poorly because of the time factor.

In part B the subject must completely understand the number-letter relationship for successful performance. How-

ever, there may be a carry-over effect from Part A, which required only a number to number sequence. If the subject is rigid, perseverative, or unable to shift,

it is easy to envision the difficulty that will be involved. However, after failure on Part B, it is necessary to determine whether or not the subject actually knows the sequence of letters in the alphabet

As is indicated by the distribution constants in Table 13 a marked variance ex-

isted between the controls and the brain injured groups. As a matter of interest, the mean score for the controls on the Trail Making A alone, exceeds the mean total score (Trail Making A & B) ob-

usually able to recognize and correct them quickly. In reference to this last point it should be made clear that on Trail making A and B only two of the brain injured cases ever realized that an

TABLE 15
Number and per cent of subjects making and correcting errors

Groups	Trail Making A				Trail Making B			
	Errors		Errors Corrected		Errors		Errors Corrected	
	N	%	N	%	N	%	N	%
Brain Injured	12	27	7	58	25	57	7	28
Neurotics	3	19	3	100	4	25	4	100
Normals	2	6	2	100	10	29	7	70
Total Controls	5	10	5	100	14	27	11	79

tained by the brain damaged cases. The degree to which these differences are to be considered significant is presented in Table 14. The raw scores have been plotted for parts A and B as well as the total. In each case (Figures 2, 3, and 4) definite bi-modality has resulted and the means do not appear to have been unduly influenced by the presence of extreme scores.

It was considered of interest to compute the number of errors committed and from this data determine the percentage of cases in each group that were able to recognize and correct their errors before failure occurred. The appropriate results are given in Table 15.

Considering the Trail making A first, the percentage difference in respect to the total number of errors made did not reflect a significant variance, but the percentage of the two groups that were able to correct their errors did. As for the Trail making B both aspects considered above yielded significant differences. In general, the controls tend to make less errors, but more important, they are

error had been committed. Their erroneous test performance seemed completely adequate to them. Finally four of the five errors that the controls made on Trail making A were caused by the omission of circle number 24. That is, in their haste to finish the test, they would draw a line directly from 23 to 25. None of the errors made by the brain damaged patients were of this nature.

The number of errors that were committed on the sample of both parts of the test were determined but these were evenly distributed.

The comparative performance of the two groups was very interesting. Unquestionably the outstanding reason for the low mean of the brain injured group on Part A was their lack of planning and anticipation. Most of the control cases would look at the test to get some over-all idea of the position of the circles and their inter-relationship before the test was started. In addition they would constantly look ahead so that while drawing a line between any two numbers they would be locating the next in the se-

quence. This we believe is similar to the anticipation and planning aspect necessary for excellent performance with the Object Assembly sub-test of the W-B. If the whole is recognized in terms of its parts and integrated before actual manipulation has begun, the object will be as-

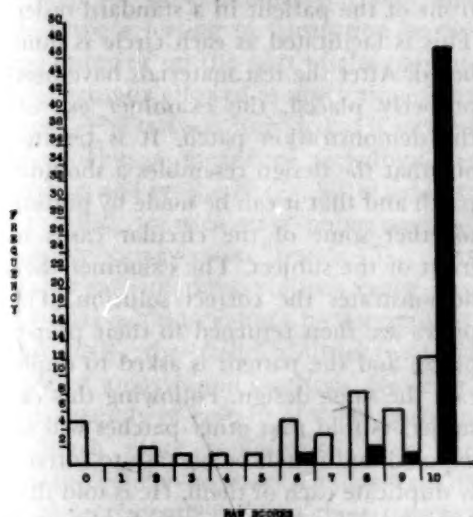


FIG. 2. Graphic distribution of the trail making (A) raw scores. Key: Solid Columns = Controls.

sembled more rapidly than if a haphazard approach is made. We have chosen to call this behavior "planning ahead" and it is probably an aspect that might well be included under the general heading of anticipation. The brain damaged patients on the other hand, would immediately start drawing a line from one to two. At this point they would stop and search for three. This method would be repeated over and over until the test was completed. This failure to "plan ahead" seemed to be responsible for 90% of the errors that they made. When they would stop to look for the next number they would use the pencil as a pointer. After the correct number had been located, they would often either begin again from the located circle or return to an in-

correct circle and continue from that point.

Trail making (B) definitely introduces a dual relationship. Most of the errors made by both groups can be attributed to the failure to adequately deal with a two aspect problem. There is consider-

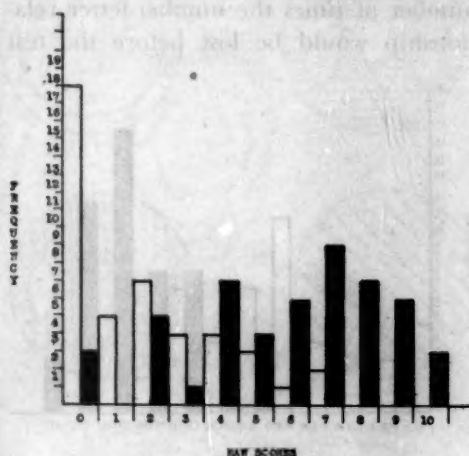


FIG. 3. Graphic distribution of the trail making (B) raw scores. Key: Solid Columns = Controls.

able evidence that rigidity and perseveration are characteristic of the brain damaged patient. With this in mind it would seem that the number-number sequence of the Trail making A should have considerable effect on the performance of Trail making B. However, failures due to a letter to letter sequence occurred as often as number to number failures. Most of the brain injured cases who did correctly complete the test, did so very slowly. They constantly repeated aloud the formula "number-letter" as they worked. The examiners noticed this in almost all of those that did succeed in addition to those who became confused. In spite of this constant reminder most of them lost the relationship before the test was completed. In these instances they would retrace part of the record or start again from the beginning.

When discussing the administration of the test it was pointed out that the examiner always permitted each part to be completed rather than to withdraw the test after an error had been made. This was done for two reasons (1) to prevent feelings of failure and (2) determine the number of times the number-letter relationship would be lost before the test

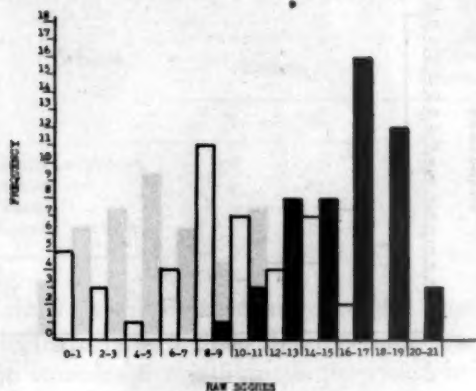


FIG. 4. Graphic distribution of total trail making raw scores. Key: Solid Columns = Controls.

was completed. It was found that those who failed averaged three errors, in addition to the original, before the test was finished. Some never were able to retain the sequence over two or three circles. These had to be constantly prompted. A very few did not make further errors but worked so slowly that if no error had been made at all their score would have been one instead of zero. Each of the controls making errors was able to complete the test without further difficulty.

III. Patch Test

The third item requires the duplication of nine colored, circular patterns which resemble shoulder patches worn on the Army uniform. One of the nine serves as a demonstration item and the other eight compose the test proper. The materials necessary for the duplication

consists of nineteen paper circles of different colors. Some of these are solid while others have different sections of the interior part removed so that by placing them one on top of another, a pattern may be formed.

The test materials are arranged in front of the patient in a standard order. This is facilitated as each circle is numbered. After the test materials have been properly placed, the examiner exposes the demonstration patch. It is pointed out that the design resembles a shoulder patch and that it can be made by putting together some of the circular cards in front of the subject. The examiner then demonstrates the correct solution. The pieces are then returned to their proper places and the patient is asked to duplicate the same design. Following this the subject is told that other patches will be exposed and it will be his task to correctly duplicate each of them. He is told that his solution must have exactly the same shape and color as the test patch that has been exhibited and that he may use as many of the circular pieces as necessary. The first test patch is then turned up. Ample time is allowed for construction and added time credit is given if the design is completed quickly. The eight test designs are in graded order of difficulty. The first one is extremely easy and although it adds absolutely nothing, in a statistical sense, to the validity of the item, it is invaluable as a confidence builder. Each patient can see the results, is aware that he has completed the first task correctly and through success develops enthusiasm for the test.

The test is terminated after two failures regardless of whether or not they occur successively. However, we have not withdrawn the test patch when the allowed time limit has been reached and the design has not been reproduced. In-

stead the examiner has given minor suggestions leading to the correct solution. The actual number of designs available for duplication is never mentioned, so that the final failure always occurs on the "last" design in the series. The scoring is on the basis of accuracy and time, although for observational purposes and to escape a feeling of frustration or disappointment on the part of the patient, he is actually allowed as much time as he needs. The test was included as it seemed to provide a means of sampling: (1) analysis and synthesis; (2) ability to shift; (3) ability to stick to a point, and (4) possible perseverative trends. To what extent each of these abilities enter into the final solution cannot be determined. Obviously, the basic abilities will be those of analysis and synthesis. However, the assembly of certain of these patterns is much more complicated than the Wechsler-Bellevue Block Design Test. It must be remembered that these patterns are being built up in depth and that in placing pieces one on top of another, parts are being blocked out. This means that the design, though rather simple to break down, must be assembled in terms of parts of the nineteen circular pieces and these sections of the whole discs may be far from apparent. This is illustrated by Figure 5. Although the bottom pattern is not a true test design it will serve to make clear the difficulty involved. In the actual test situation each design, with one exception, can be duplicated only by putting together specific discs of the 19 provided. These must be chosen from a number whose characteristics are similar to the parts of the actual test patch. Although most of the patterns are simple to analyze, a few are very difficult. The difficulty consists largely in determining what is figure and what is ground. If the subject starts with an as-

sumption that is incorrect and has lost the ability to "shift", failure usually follows. Some designs are more easily solved if the patient begins by selecting the top piece; others are assembled more easily

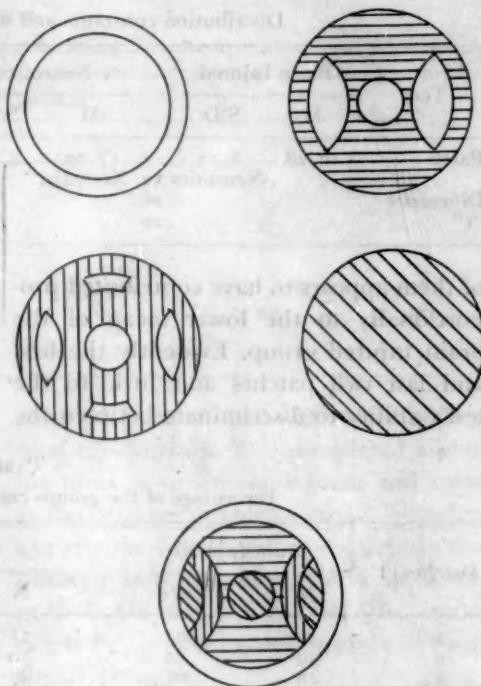


FIG. 5. Illustration of a patch assembly.

from the bottom up. If the same approach is employed in every case, it creates an added hardship. The aspects and functions necessary for success will be discussed in greater detail when considering the brain injured patients' performance.

The distribution constants and significance of mean differences are presented in Table 16. A highly significant variance was found to exist between the control and brain injured groups. This being true it was of interest to determine whether any one or two of the designs were responsible for the poorer scores obtained by the brain damaged patients. The percentage distribution of each

group successfully assembling the individual designs is shown in Table 17. The results suggest that the patterns were arranged in order of difficulty and each

As a further investigation the distribution constants and significance of mean differences were computed for the actual time taken to assemble the patterns. With

TABLE 16
Distribution constants and significance of mean differences

Test	Brain Injured		Neurotics		Normals		Total Controls	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Patch	10.28	6.13	17.00	4.46	16.74	4.08	16.82	4.20
Difference								
"t"								

Neurotics vs. Normals.

Controls vs. Brain Injured

.26

6.55

.20

6.04

of them appears to have contributed proportionally to the lower mean of the brain injured group. Evidently the first and last two patches add little to the test's ability to discriminate between the

the exception of the first design no significant differences were found. These results are similar to those that were determined in an earlier study of the MAS (1). Both the Patch and the Block Designs

TABLE 17
Percentage of the groups correctly assembling each patch

Patches	Brain Injured		Controls		Difference	D/SD Diff.
	N	o/o	N	o/o		
1	40	93	51	100	7	1.84
2	30	70	50	98	28	3.84
3	28	65	47	92	27	3.29
4	25	58	47	92	34	4.05
5	17	40	39	76	36	3.76
6	13	30	33	65	35	3.65
7	10	23	29	57	34	3.62
8	3	7	9	18	11	1.67
9	1	2	8	16	14	2.50

two groups. The first is much too easy and the last two are too difficult.

A final quantitative check was made to determine whether the controls and brain injured cases who were able to correctly construct the designs, differed in relation to the speed with which they were able to assemble the patterns. With the exception of the first design, the results indicate (Table 18) that if the brain injured patient is able to duplicate the pattern, he does it quickly enough to obtain as much time credit as do controls.

tests seem to operate according to an "all or nothing" principle. That is, either the designs or patches are solved with normal speed and accuracy, or they are not solved at all.

Continuing the same procedure as was established in the treatment of the memory data, the raw scores of the patch test were plotted for both groups. Again a bimodal curve resulted (Figure 6). However, as was found before, a number of brain damaged cases obtained scores near or above the mean of the controls and

vice versa. The scores of both groups appear to be well distributed and it does not seem that the means have been unduly affected by the presence of a number of extreme scores.

differences are, however, a matter of degree rather than an attribute of any group.

The second qualitative observation was the relative inability of the brain dam-

TABLE 18
Percentage of both groups obtaining time credit

Patched	Brain Injured		Controls		Difference	D/SD _{diff}
	N	o/o	N	o/o		
1	31	78	51	100	22	3.39
2	22	73	44	82	9	.09
3	16	57	36	77	20	1.79
4	19	76	41	87	11	1.03
5	10	59	22	56	3	.21
6	7	54	17	52	2	.12
7	4	40	15	52	12	.66
8	2	67	2	22		
9	1	100	3	38		

Qualitatively, a number of definite differences between the groups were noticed. Time and time again the brain injured patients would begin by selecting a number of pieces which would be arranged in a variety of ways; these would be discarded and others selected, but almost immediately they would return to the ones they had chosen originally and proceed to arrange and re-arrange them as had been done before. This entire procedure would often be re-enacted until the time limit had been exceeded. This inability to shift not only operated in the manner outlined above but extended to the inability to rearrange pieces and rigidity in approach (persistently starting from top or bottom regardless of success achieved) from design to design. This perseverative and rigid behavior was also noticed in a number of the control cases. However, the controls could and did alter the order of the cards, select new pieces, and if the pattern was not readily assembled in starting from the top, they would try it from the bottom. In general it is suggested that these

aged patients to deal effectively with a dual relationship. The completed assembly must have the same form and color as the original to receive credit. Very frequently the form would be correctly duplicated but the color would be disregarded. On the other hand, the colors might be the chief concern and the form would be ignored.

Third was the lack of plan. The brain damaged patient showed less of an integrated or unified approach. A definite plan or method was obvious occasionally, but it was so nebulous that when the slightest difficulty was encountered the entire approach often disintegrated.

Fourth was the brain injured patients' seeming inability to analyze the pattern to be duplicated. A number of the patients would look at a design and say, "red is the bottom", and pick up a red piece when actually a yellow one was needed. The fifth was the inability to synthesize. In these instances the patients would make the correct assumptions but would be unable to select certain cards having parts necessary for successful com-

pletion. Usually a partially correct solution would be offered in these cases.

The sixth was a dual factor. Some of the brain injured cases arrived at the correct solution, but they worked so slowly that they failed to receive credit. Failure was due directly to slowness in trying the various pieces. On the other hand, a

occurred, but they are the ones that were observed most often. It was quite clear to the examiners that none of the factors described above was the sole cause for failure. The extent to which each may have been responsible is a subjective consideration and any assumptions that might be made would in all probability be misleading and inaccurate to some extent.

IV. The Goldstein-Scheerer Cube Test

The fourth sub-test we have used in our screening device is the Goldstein-Scheerer Cube Test (9). The material consists of four one inch, vari-colored, square, wooden blocks and a series of colored designs, adopted from those developed by Kohs (18). The procedure in administration is familiar to every clinician. After placing the four blocks before the subject, the examiner states that they are all alike, i.e., on one side they are all red, another side all blue, another side yellow and blue, etc. The examiner must be sure that the subject understands that each block is like every other one. A design is then placed before the subject, and he is asked to duplicate the design using all four blocks. Thereafter no further instructions or aids are given the subject. Every move, block placement, and evidence of trial and error behavior are recorded as completely as possible. If the design has not been satisfactorily duplicated in three minutes, the design is removed. The examiner says, "Let's put this one aside and try another. We will return to this one later". Because brain injured patients frequently show overt manifestations of frustration as a result of failure, it is wise to avoid accentuation of poor performance. After the series of twelve designs have been attempted (Step I), the next step is used if necessary. In Step II the designs are the same size

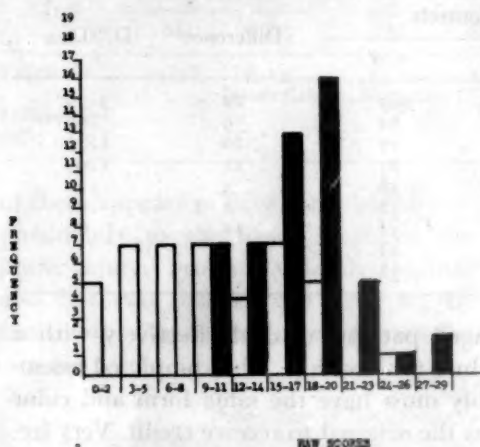


FIG. 6. Graphic distribution of patch test raw scores. Key: Solid Columns = Controls.

number worked so quickly that they would correctly assemble a design and then tear it down before they realized that they had correctly duplicated the patch. This behavior was also occasionally noticed among the controls, especially in the neurotic group.

Finally, there was the effect of help or the factor of learning. If one of the patches early in the series was failed, the examiner demonstrated the correct assembly. Most of the controls were greatly aided and applied the observed techniques to the next design. The brain damaged patient on the other hand, rarely gained anything from watching a pattern duplicated.

The types of behavior just described are neither arranged in order of frequency or importance. Obviously these are not all the behavioral variances that

as the blocks, but are in no other way different from the designs used in Step I. Only the designs failed in Step I are repeated. If any failures occur, Step III is presented. In this step, the designs are again the size used in Step I, but heavy black lines have been drawn through the pattern to indicate the exact position of each of the four blocks. If any of these are beyond the subject's capability, Step IV is administered. The designs in this step also have the heavy black lines to indicate the block positions, and in addition are the size of the actual blocks. Failure at this point terminated the formal test presentation as far as this study was concerned, although Goldstein described a further step of having the subject attempt the reproduction of a pattern made up of actual blocks. In our cases the examiner placed one block in its correct position upon the design, and asked the subject to do the same with the remaining blocks. This was done to permit an eventual solution and thus relieve the subject's sense of failure.

This item has been included in the test for three reasons: (1) Because of the intellectual functions tested. Goldstein and Scheerer (9) believe that in general, success depends upon the ability to assume the "abstract attitude". A discussion of this term appears in their monograph. It is our opinion that it resolves ultimately to the ability to analyze, synthesize, anticipate, plan and shift. This last function is extremely important when designs number 7, 10, 11 and 12 are reached. These are diamond shaped rather than square. The subject has constructed all previous patterns at a 180° angle. The presentation of the diamond shaped designs necessitates a shift or change in approach. The need for analysis or synthesis is obvious and does not require explanation. A number of rea-

sons for failure are given by Goldstein and Scheerer. These seemingly overlap to such an extent that direct application becomes difficult. (2) To check Goldstein and Scheerer's statement, "patients suffering from functional disturbances of the brain cortex are not able to adopt the specified abstract attitude required in this test" (9). This assumption has been contested by Halstead (11) who has noted that patients with frontal injury have been able to think in a definite abstract manner. (3) To attempt to determine the practicability of formulating a method of scoring to enable validity determination. A clinician does not select tests at random. They are chosen because they are known to tap certain functions and fulfill certain diagnostic needs. Reliabilities and validities have been established to determine the measure's limitations. It is not enough to describe behavior, one must know the significance of its characteristics and the frequency of occurrence in similar cases.

The basic premise of this paper is that it is necessary and valuable to observe the brain injured person as an integrated whole. This does not necessitate disregard of statistical aid in understanding data that has been collected.

The first approach was to determine the number of control and brain injured cases that failed each of the four steps. These results are given in Table 19. Most of the brain injured group were able to adopt the necessary "abstract attitude" and of those that did fail Step I only a few were unable to alter their behavior before the final step was reached. It is of interest that nearly all of the controls that failed the first step did not require Step II. That is, they recognized their errors and upon re-presentation of Step I they were able to successfully duplicate the patterns. Some of the brain injured

patients were also able to do this. Indications were present that learning did take place in both groups but to a different degree. The foregoing did not apply to those brain damaged cases failing designs 10, 11 and 12. Each of these required the administration of Step II. These de-

ing device. However, we realize that certain limitations may have been placed on the test by such aspects as the type of case used, recency of injury, locus of lesion, etc. To determine whether the discriminatory ability of the item could be increased, a multiple approach was made

TABLE 19
Number and per cent of both groups failing the first four steps of the Goldstein-Scheerer cube test

Design	Failed Step One				Required Step Two				Required Step Three				Failed Step Four			
	Brain Injured		Controls		Brain Injured		Controls		Brain Injured		Controls		Brain Injured		Controls	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
1	12	27	9	18	3	25	I	II	2	17			I	2		
2	4	9	2	4	3	75			2	50			I	2		
3	4	9	I	2	4	100			2	50			I	2		
4	5	11			3	60			2	40			I	2		
5	3	7			2	67			2	67			I	2		
6	5	11			4	80			3	60			2	5		
7	10	23	3	6	10	100	I	33	7	70			6	14		
8	9	20	I	2	8	80			4	44			3	7		
9	9	20			6	67			3	33			2	5		
10	13	30	I	2	13	100			7	54			5	11		
11	14	32	I	2	14	100	I	100	8	57	I	100	5	11		
12	13	30			13	100			8	62			5	11		

signs particularly emphasize the ability to shift. It was found that fourteen of the brain injured patients tended to continue to construct designs 10 and 11 in the same position as those preceding, and sixteen patients had the same difficulty with number 12. In each case eight of them were unable to shift their mode of attack and therefore failed. In every instance the design was correctly assembled but was not placed at an angle. All but three that failed design 7 did so for the above reason—the others were concerned with the necessity for a white background or offered a single block as the solution. It would appear that in general failures due to inability to break the design down and reassemble it were relatively few in number.

These quantitative results were disappointing from the standpoint of a screen-

ing system. First the distribution constants and the significance of mean differences for the time taken to complete each design were computed. This procedure was applied only to the data obtained from those successfully completing the design at the first level. The second was an attempt to determine the number of incorrect moves that were made by both groups. The third was a study of the order or sequence employed in placing the blocks. That is, did the patient always work from top down and left to right or exhibit some other order that was regularly employed? Finally the number of correct first block placements were determined. None of these methods uncovered differences that were significant. In general the results indicated that if the patient was able to duplicate the

design it was done with normal facility.

Qualitatively the behavior observed was as described by Goldstein and Scheerer (9). No attempt was made to

give the examiner an indication of the patient's pre-injury intelligence. This was found to be necessary because a few of the cases tested, who were of low intel-

TABLE 20
Intercorrelations among the MAS sub-tests

		Inf.	Arith.	Comp.	Simil.	Dig. Span	Pic. Comp.	Pic. Arr.	Dig. Symb.	Obj. Assem.	Block Des.
Vocab.	W-B										
	Controls	.84	.60	.57	.72	.23	.55	.42	.48	.31	.35
Inform.	Brain Inj.	.83	.62	.72	.72	.43	.61	.52	.43	.34	.44
	W-B		.60	.67	.68	.48	.47	.38	.56	.22	.49
Arith.	Controls		.63	.62	.73	.14	.60	.45	.58	.34	.54
	Brain Inj.		.60	.72	.74	.47	.52	.41	.37	.26	.27
Compre.	W-B			.52	.60	.44	.40	.37	.43	.23	.51
	Controls			.43	.58	.29	.45	.32	.44	.38	.51
Simil.	Brain Inj.			.66	.62	.56	.41	.54	.52	.40	.54
	W-B				.72	.44	.46	.39	.48	.29	.47
Dig. Span	Controls				.51	.43	.45	.31	.53	.33	.37
	Brain Inj.				.64	.42	.45	.49	.45	.26	.33
Pic. Comp.	W-B					.38	.46	.49	.51	.31	.54
	Controls					.22	.54	.34	.49	.26	.48
Pic. Arr.	Brain Inj.					.46	.46	.42	.41	.30	.42
	W-B						.30	.26	.54	.16	.40
Dig. Symb.	Controls						.29	.26	.03	.04	.33
	Brain Inj.						.34	.46	.23	.23	.40
Obj. Assem.	W-B							.39	.40	.44	.57
	Controls							.29	.58	.56	.50
Block Des.	Brain Inj.							.60	.54	.50	.56
	W-B								.44	.27	.48
Vocab.	Controls								.28	.42	.65
	Brain Inj.								.63	.47	.53
Inform.	W-B									.32	.54
	Controls									.50	.62
Arith.	Brain Inj.									.58	.62
	W-B										.54
Compre.	Controls										.58
	Brain Inj.										.67

classify the failures according to the causes listed by them. It was felt that such subjective categorization made the reliability and validity of the indications given of questionable value.

V. The Stanford-Binet Vocabulary Test

The final sub-test is the Stanford-Binet vocabulary test (31). It was included to

intelligence, were found to display behavior and obtained scores similar to those of the brain injured patients. However, we did not have enough of these cases to present any definite results. It is possible that some characteristic behavior exists which may serve to differentiate between these two entities. Until this point can be resolved, the vocabulary test must be relied upon for this purpose. The de-

ficiencies of such technique have already been discussed.

In most instances we have found that it is possible to dispense with this item. Previous employment, education and other data usually supply sufficient information regarding the patient's approximate pre-injury level. However, a few cases were encountered in which the necessary data could not be obtained. Here the vocabulary test was found to be helpful.

VI. Sub-Test Interrelationship

Quantitatively, a final approach was the determination of the degree of sub-test interrelationship which existed for both the MAS and the proposed screening test. Table 20 presents the MAS intercorrelation coefficients. Included is a Wechsler-Bellevue matrix adapted from that given by Wechsler (32). There are several points of interest: (1) The extent to which the brain damaged and control matrices are similar; (2) the W-B and MAS coefficients appear to agree basically; and (3) if those sub-tests found to be diagnostic are considered, a very high average correlation is found to exist for the brain injured and control groups, the brain injured mean being slightly, though not significantly, higher.

The first point is added suggestive evidence that the difference between the groups is purely quantitative. However, factor analysis technique should be applied to this data. Results so obtained might provide evidence as to whether any functions had been actually lost or dropped out of the pattern.

The second point adds support to previous findings (1) that the W-B and MAS are interchangeable instruments. In addition W-B's had been administered to a number of control and brain injured patients who had previously taken the

MAS. Although the numbers were small, an r_{xy} of .91 was obtained. Practice effect, due to sub-test similarity, and long standing patient-examiner relationship were undoubtedly reflected in the coefficient. Larger groups must be used before the above findings can be accepted with confidence.

The third point needs little discussion. None of the r_{xy} s are extremely high, but most of them indicate the presence of a marked relationship. Every clinician knows that the sub-tests of a diagnostic measure should bear as little relationship to one another as possible without sacrificing validity and reliability.

From this standpoint, it will also be of interest to consider the intercorrelations of the screening device sub-tests. The results of these computations are shown in Table 21. None of the intercorrelations for the control group are significant at the 1% level, except that for the two parts of the Memory test. However, a marked correlation between the scores obtained by brain injured patients on certain sub-tests should be noted. Specifically, the relationship must be considered between the Patch test and the Trail Making Test and the relationship between parts A and B of the Trail Making. It will be noted also that insignificant correlations were found for the control patients on these tests.

It has been pointed out earlier in the paper that a highly significant difference was found between the mean scores for brain injured and control patients on these tests. This difference was explained primarily on the basis of clinical observations of the difficulty encountered by the brain injured patients in planning, anticipation, and coping with a dual relationship seemingly necessary for successful performance. These difficulties were not observed to any marked degree in

the control groups. Inasmuch as common difficulties contribute to greatly lowered scores for the brain-injured persons on each of these tests, we believe that an explanation of the relationships between the scores is offered. It may be argued that this is not a satisfactory explanation inasmuch as it might just as

ing to consider the relationship between these scores and those on other tests considered similar in nature. The correlations between the sub-tests of the screening device and the sub-tests of the MAS are presented in Table 22. It will be noted that in general the correlations are insignificant. It has been previously

TABLE 21
Intercorrelations among screening measure sub-tests

Variable	Groups	Patch Test	Total Trail	Trail B	Trail A	Total Free Association
Total Memory Score	Controls	.16	.12	.13	.04	
	Brain Injured	.17	.07	.21	.08	
Patch Test	Controls		.07	.08	-.06	
	Brain Injured		.55	.52	.45	
Trail Making B	Controls				.26	
	Brain Injured				.40	
Questions	Controls					.61
	Brain Injured					.75

easily be expected that controls have abilities necessary for successful performance and therefore should also reveal a relationship. Of course the factor of individual differences undoubtedly plays a large part in reducing the relationship of these scores for the controls, and is also probably a factor in the accounting for the correlation for the brain injured persons. We can only assume that changes resulting from brain injury impair performance in the respects necessary on these tests to the extent that low scores on each show less variance.

Inasmuch as significant correlations found between the Patch test, Trail Making test and parts A and B of this test, have been explained on the basis of impairment of abilities necessary for successful performance, it will be interest-

pointed out that Object Assembly and Block Design required the use of planning and anticipation. The Trail Making and Patch tests, also requiring these abilities, show significant correlations with the MAS sub-tests. This may be considered suggestive evidence supporting our explanation that the relationship is present because brain injury causes impairment which may reduce the degree of individual differences in the performance of certain tests.

Note the low correlation between the Memory test and the Digit Span. It is obvious that they are not measures of the same function, at least for the brain injured patients. It has been suggested (23) and supporting evidence has been offered (1) that the Digit Span test primarily measures attention.

D. CRITIQUE OF THE SCREENING TEST

The comparative results of each sub-test have been considered. The question now arises, does the measure meet the

patients refused to allow the pieces to be put away until every design had been completed to their satisfaction. Three of the brain injured patients asked one of

TABLE 22
Intercorrelations among the screening and the MAS
sub-tests for brain injured patients

	Vocab.	In- form.	Arith.	Gen. Comp.	Simil.	Dig. Span	Pic. Comp.	Pic. Arr.	Dig. Symb.	Obj. Assem.	Block Des.
Total Free Association	.13	.34	.29	.08	.28	.16	.23	.18	.08	.22	.15
Questions	.26	.42	.02	.09	.21	.04	.24	.17	.09	-.19	.07
Total Trail Making	.38	.45	.45	.20	.31	.18	.19	.41	.30	.68	.62
Patches	.22	.20	.24	-.07	-.05	.18	.33	.23	.17	.42	.47

Key—For an N of 44 an r_{xy} of .384 is necessary for significance at the one per cent level.

requirements for a screening test that were previously established? These will be discussed in the order previously given.

(1) *Test must be short.* The average time taken to administer the test was

the examiners if extra sets of the test were available as they wanted to "try them on their friends".

In the experience of the examiners, rarely has a test proved to be as interesting. Not a single instance of rejection

TABLE 23
Screening sub-test validities

Groups	Free Association	Questions	Total Memory	Trail A	Trail B	Total Trail	Patches
Total Controls	.62	.51	.61	.65	.79	.83	.66
Normals	.63	.52	.62	.64	.82	.83	.65
Neurotics	.58	.43	.55	.51	.80	.74	.62

25.6 minutes, with a range of from 16 to 38 minutes. The examiners have on occasion given 10 tests within an eight hour period.

(2) *Interesting.* Each part of the test seemed to catch and hold the interest of the patients. Those that were relatively uninteresting, the Trail Making and Goldstein-Scheerer Cubes, were either preceded by a test of intense interest or were accomplished so rapidly that little opportunity was present to develop any degree of dislike. The Patch test developed such enthusiasm that frequently the

occurred nor was such a tendency noted. Co-operation, effort and motivation were considered optimum in every case.

(3) *Easy.* In general all the sub-tests but Trail Making were so constructed that the brain injured patient was able to exhibit successful performance on at least the initial parts of the test. The method of dealing with failure on the Trail Making test has already been discussed. With the exception of the performance of both groups on the foregoing test, the scores were well distributed.

(4) *Relatively unaffected by neurotic trends.* The results that were obtained suggested that the sub-tests used were not affected by neuroses. However, a larger group including all types of neurotic disorders must be tested to assure confidence in this respect.

(5) *Sample those functions that seem to suffer most as a result of brain injury.* Not every field of possible impairment resulting from brain injury has yet been explored. However, the sub-tests seem to include a variety of those functions that appear to suffer most heavily.

(6) *Understandability.* Over half of the brain injured and control cases were asked what they considered the purpose of each sub-test to be. Each of them had some definite logical idea as to the rationale involved. In addition, all spontaneous comments were recorded and approximately thirty per cent of all the brain injured patients felt that this was the first sensible test that they had been required to take and none of them were of a derogatory nature. This may be compared to the, "I don't know what good this test is going to do me" attitude that some of the MAS and W-B sub-tests aroused.

(7) *Have a minimum dependence on previously learned material.* The Trail Making test is the only one that would seem to have any relation to "old learning". Numbers (the sequence, one, two, three) and the alphabet have been familiar to most since childhood. This may partially account for the correlations exhibited between Trail Making and Vocabulary, Information and Arithmetic sub-tests (Table 22). In relation to this point it should be noted that all other sub-test correlations are extremely low.

(8) *Performance items should be included.* Three of the five sub-tests re-

quire the patient to work with his hands and the others require verbalization. It is felt that an ample sample of the patient's behavior is obtained through the administration of the screening test.

(9) *Validity.* At numerous points throughout the paper the subject of validity has been considered. It is admitted that at best only a partial validity can be determined from the obtained data. The r_{bls} coefficients that were computed are shown in Table 23. The column headed "groups" denotes the composition of the total group used. That is, total controls plus the brain injured comprised the first category used. In every instance a marked relationship was indicated between the no brain injury category and high scores on the sub-tests. These findings may be compared with the results given in Table 4. The relationship appears to be most marked for the "normals" and least marked for the "neurotics". Finally, biserial coefficients were determined for all sub-tests with a group composed of neurotics and normals. The correlations were all so small that they could not be considered significantly greater than zero, the largest being .21. How a group of psychotics or mental deficientes would compare still remains to be answered. Until these and other comparative results can be obtained the true validity of the scale will not be known.

(10) *The test should be reliable.* The reader is referred to work already accomplished (4).

(11) *Directions should be simple, clear and easily understood.* Demonstration items, samples, and carefully worded directions prevented any failures that might have been attributed to hazy or unclear explanations. Very few of the patients in either group asked for added information and none of the failures re-

flected the lack of understanding of what was required.

(12) *All performance tests should be of such nature that they can be accomplished by gross muscular movements.* It has been determined that with only one functioning hand every test can be accomplished within the range of normal performance. Of all the sub-tests the Trail Making offered the greatest amount of difficulty to the patient who had the use of only one hand. This difficulty could be overcome by fastening two copies of the test, one with the sample and the other with the test side up, to the desk top with scotch tape. The loss of the use of the preferred hand is an additional aspect that must be considered. Only two such cases were found and in each instance the performance fell within the normal range.

In addition to these twelve points is the consideration that in its present form

the test is not suitable for use unless the examiner has had considerable clinical experience. There has been no attempt made to obtain a final or total score which might be fitted into such categories as: Normal, slightly less normal, relatively suspicious, etc. This procedure appears to be frequently misleading. The screening test has been designed so that both the quantitative and qualitative aspects can be evaluated. In short, it is aimed at sampling behavior and the total performance exhibited by the brain damaged patient. Such considerations are difficult to reduce to a numerical score which can be readily categorized. Finally, the groups used in this study were all limited numerically. Further work must be carried out with this test or others of a similar nature. Norms based on groups as small as were considered can often be misleading despite the most exacting statistical analysis.

VI. SUMMARY AND CONCLUSIONS

1. Four tests previously used to determine the presence of brain injury were considered in terms of their comparative advantages, disadvantages, and rational. These tests were the MAS, Shipley, Hunt and Rorschach. It is suggested that the Rorschach is the most useful for this purpose. The value of the measure arises from its ability to tap many aspects of the individual personality untouched by the other three. Inasmuch as the understanding of the brain injured patient does not lie alone in an inventory of intellectual functions, the wider scope of this test becomes doubly important.

2. The need for a screening device was stressed. Regardless of the ultimate value of all of the above measures each had certain disadvantages as a preliminary or screening test.

3. A five sub-test screening measure was proposed. It consisted of the Memory, Trail Making and Patch sub-tests from the AIT, the Goldstein-Scheerer Cube test, and the Stanford-Binet vocab-

ulary. These were chosen as they seemed to test the following functions; (1) recent memory, (2) abstraction ability (analysis and synthesis), (3) ability to deal effectively with a dual relationship, (4) ability to plan and anticipate, (5) perseverative trends, and (6) the ability to shift. Tests measuring specific functions were selected because previous studies (1,2) had suggested that they were retarded by the presence of post-traumatic brain injury.

4. The administration of the screening test to a group of definite brain injured and control patients (normals and neurotics) indicated definite quantitative and qualitative variance. Whether these obtained differences are to be considered characteristic of only post-traumatic brain injury could not be determined. Further validation either with this test or measures of a similar nature, using larger groups and including other personality variants, must be accomplished before this point can be resolved with any assurance.

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